MARCH, 1956

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Akron Group Symposium, page 813

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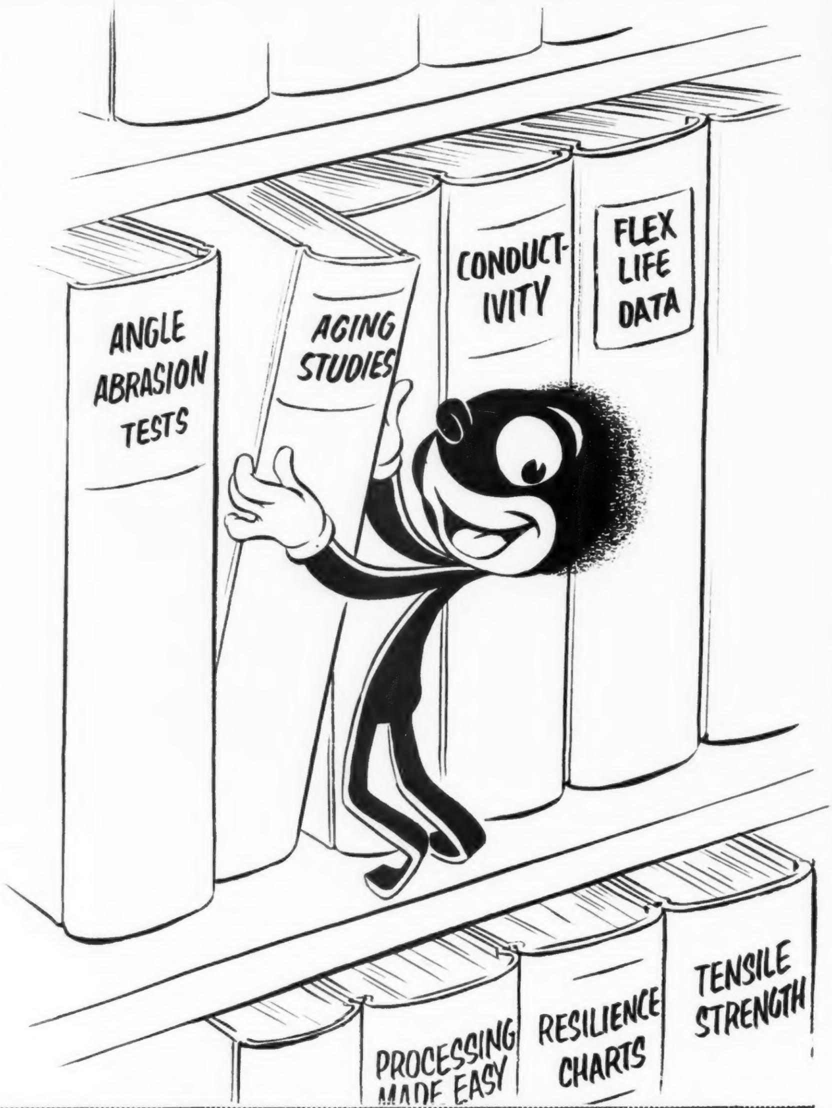

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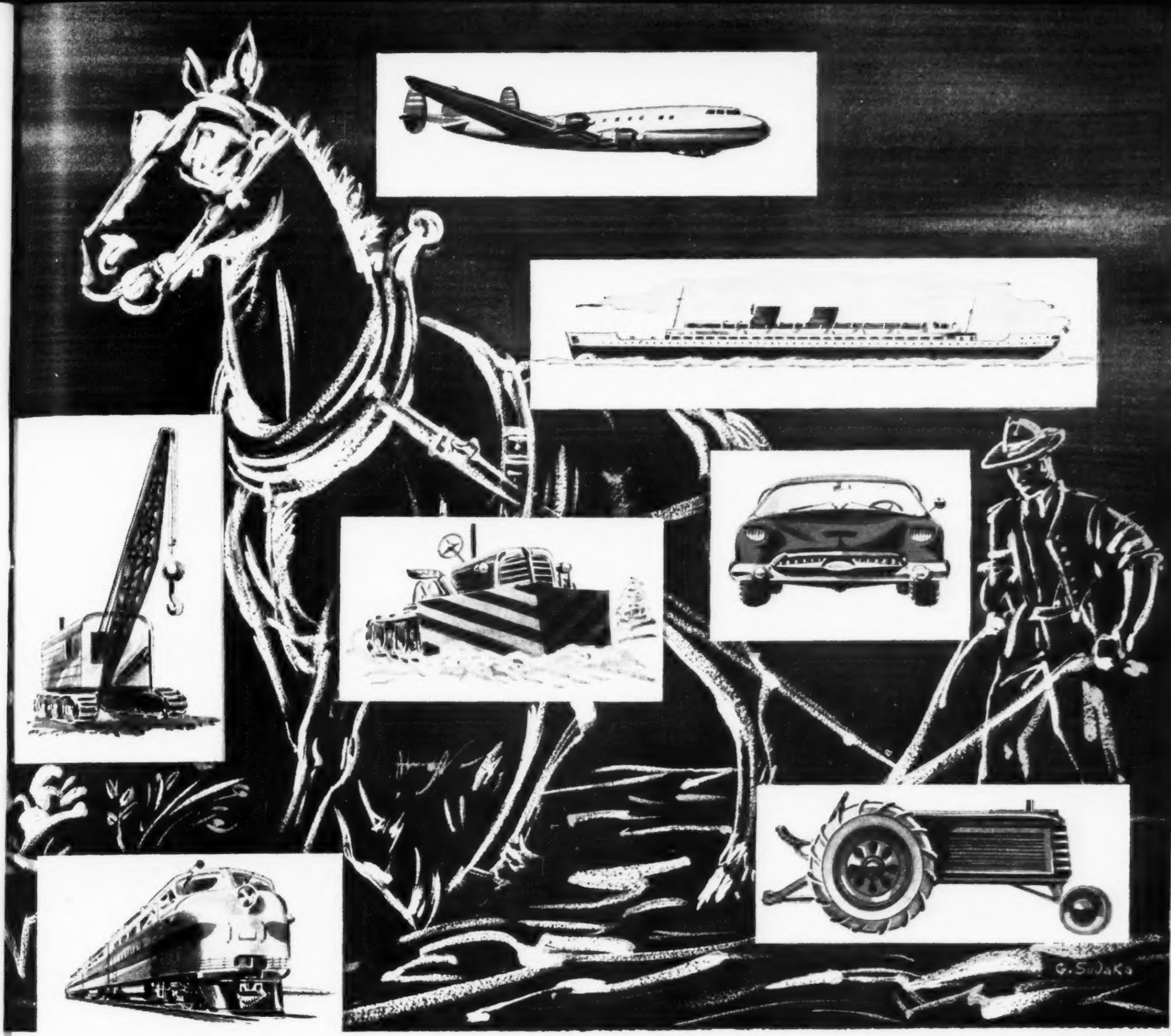

key to a seal of c

To many manufacturers and transporters of LP Gases, leakproof ball valves are essential to safe, loss-free operations. But developing such valves was not so simple as it may seem.

The secret of leakproofness lies in the ball seat. It must provide an effective seal, without binding, and must maintain its close fit, despite continual use and exposure.

Many valve seats of different materials were tried and tested with little success. However, precision-molded rubber seemed to hold the key. Many tries later, a compound of CHEMIGUM, reinforced with PLIOLITE S-6B, was developed which filled the bill well enough for the valve to be tested and listed by Underwriters' Laboratories, Inc., for use with hazardous gases and liquids.

CHEMIGUM is a nitrile rubber–first and finest in the field. It was selected for its ease of processing, excellent physical properties and its unusual resistance to oils, greases, chemicals, heat and abrasion – all of which would assure a close fit, regardless of operating conditions.

PLIOLITE S-6B is an easy processing, high styrene copolymer for reinforcing rubber. It was used to impart just the right hardness and smoothness for easy operation of the valve and to permit molding to extremely close tolerances.

Valve seats are but one of many types of precision-molded rubber parts that can be improved with CHEMIGUM and/or PLIOLITE S-6B. How can they help your product? Full details and the latest *Tech Book Bulletins* on both of these use-proved polymers are yours by writing to:

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nitrile rubber

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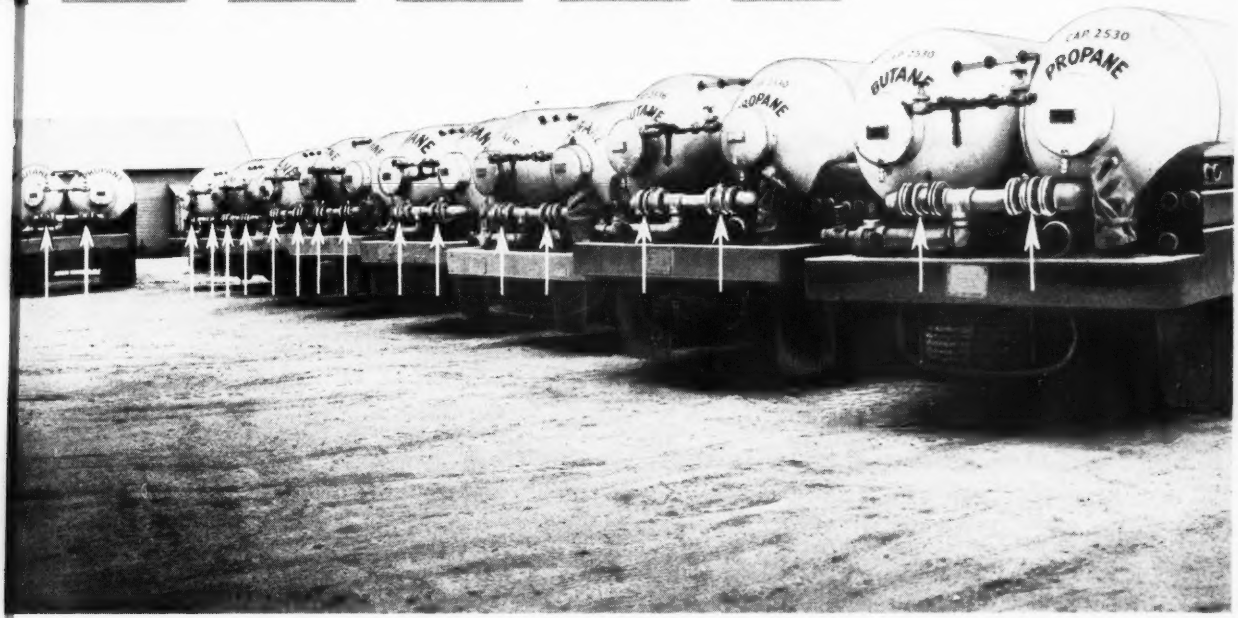
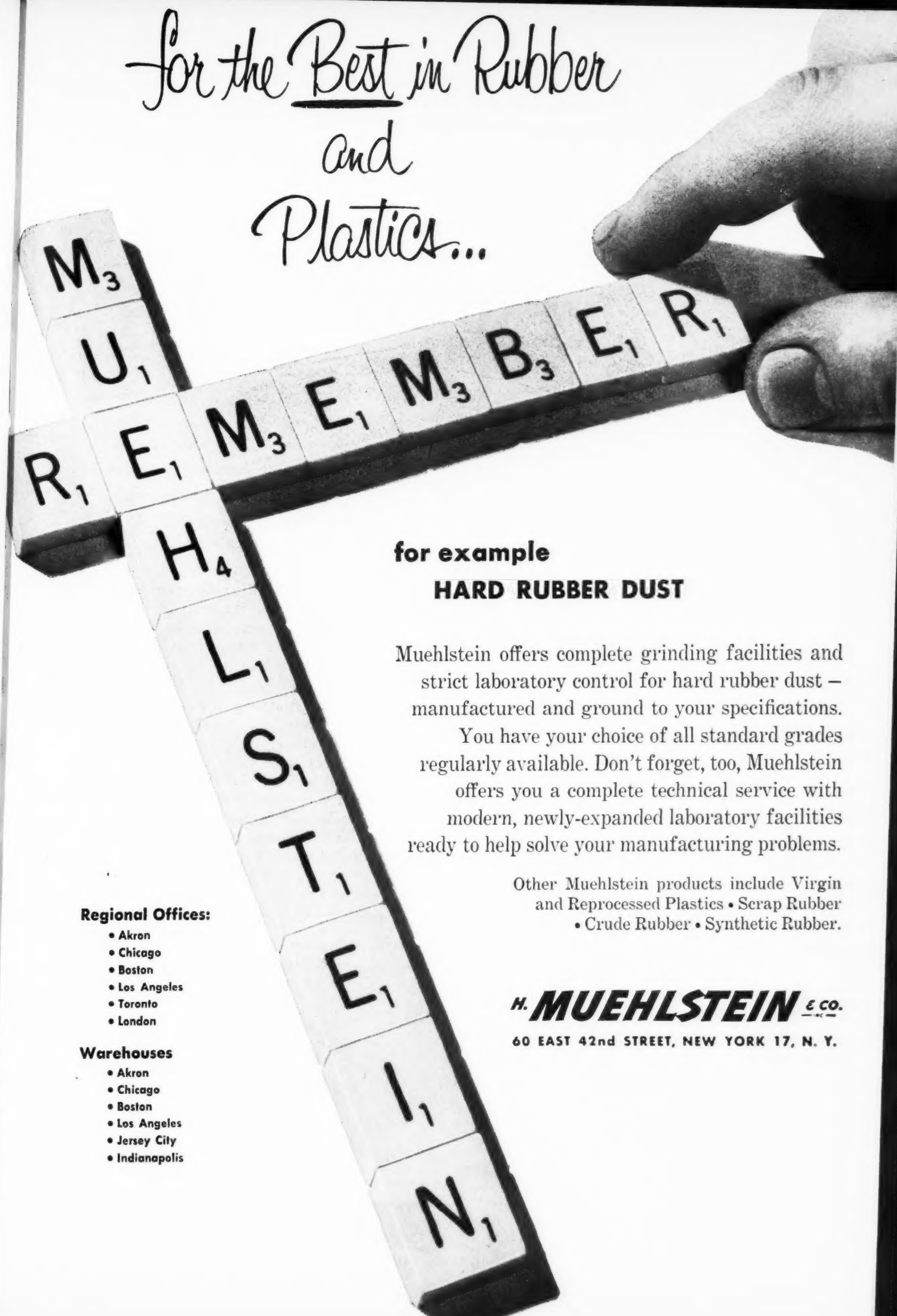


SEALING UNLIMITED against gases and liquids by this ball valve is assured by the seat molded of CHEMIGUM, reinforced with PLIOLITE S-6B. Photos courtesy International Packings Corporation, Bristol, N.H., and Rockwood Sprinkler Company, Worcester, Mass.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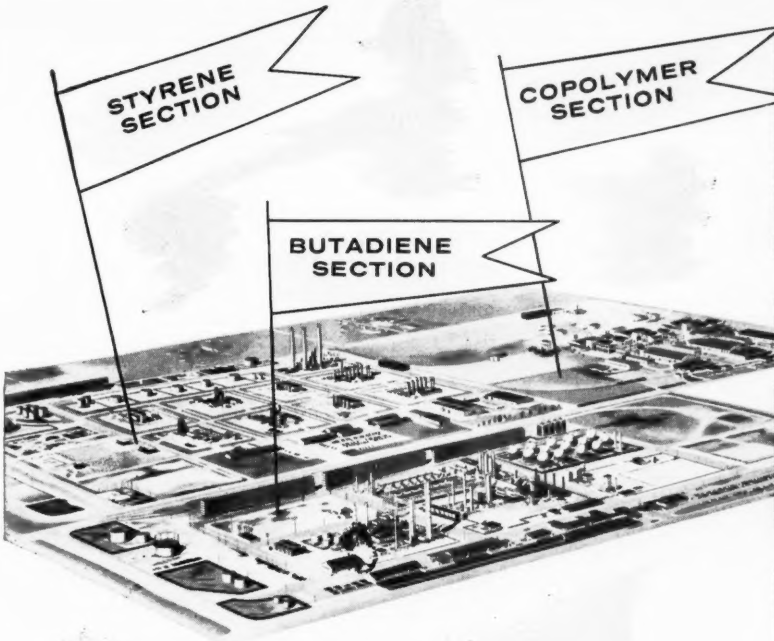
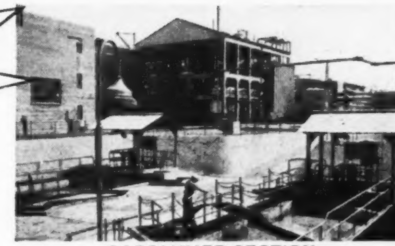
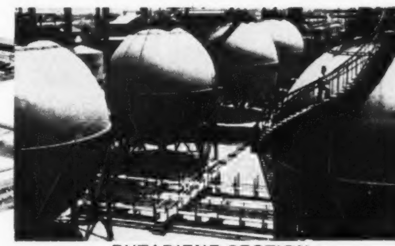




COPOLYMER SECTION



BUTADIENE SECTION

STYRENE SECTION

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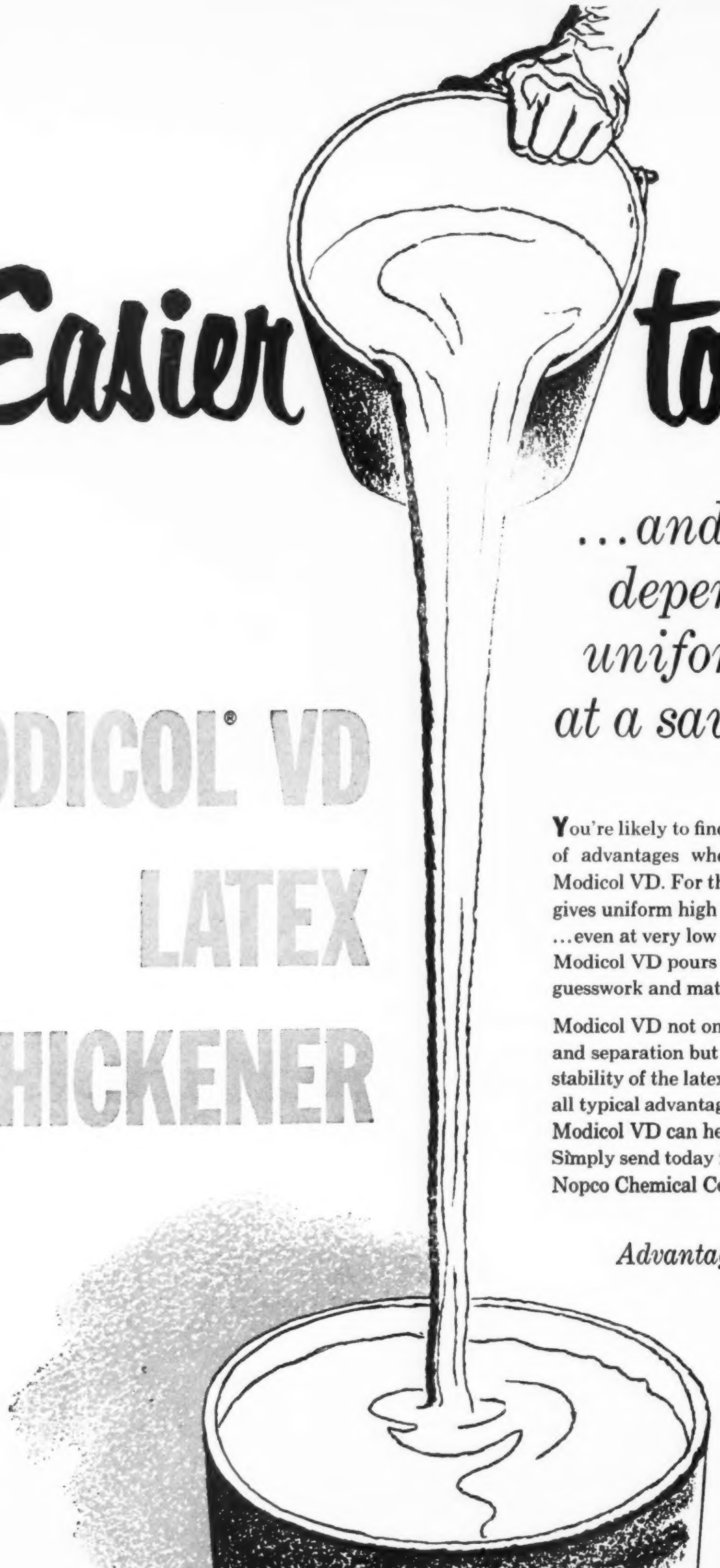

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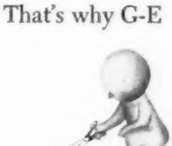

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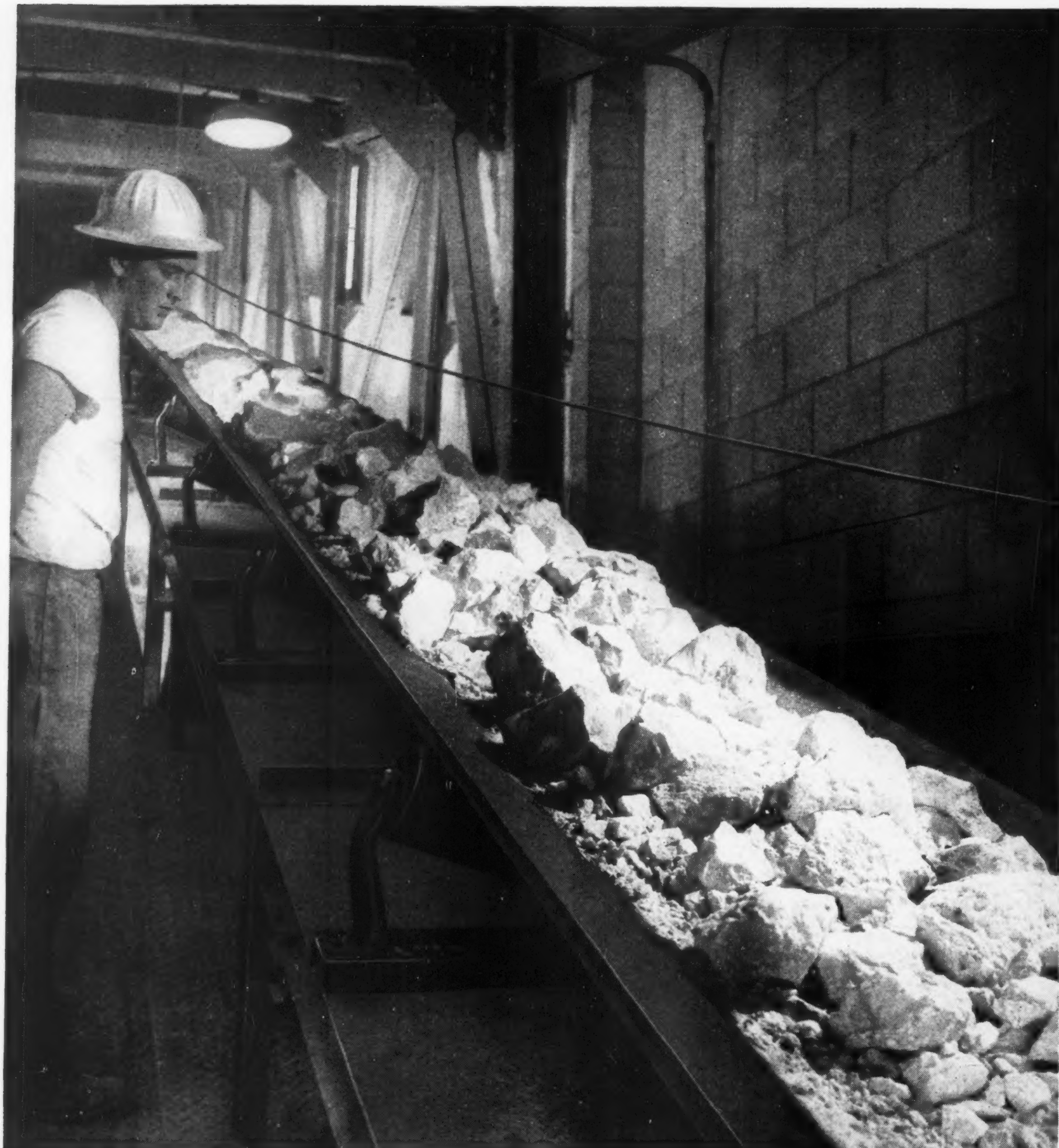

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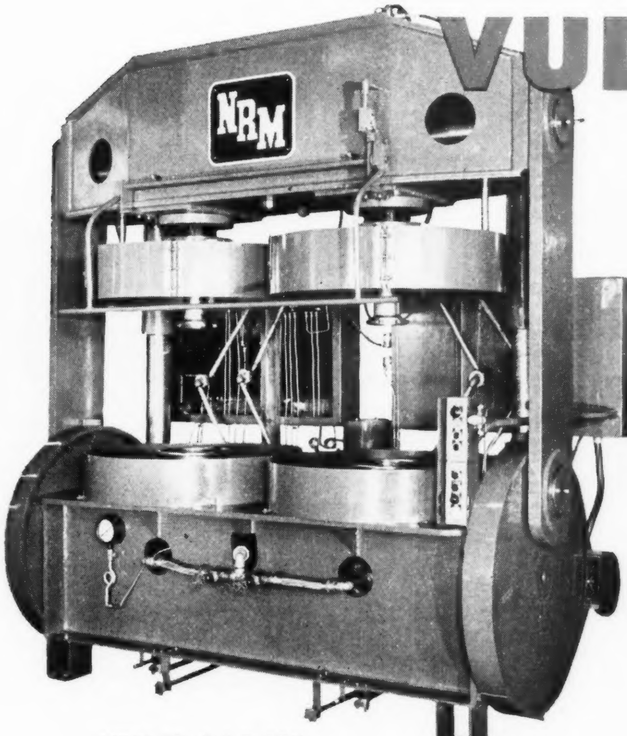
With the NRM 40″ Packless *Autoform* VULCANIZER



NRM Model E 40″ Packless Autoform VULCANIZER

- ***LESS MAINTENANCE***
- ***SIMPLER OPERATION***
- ***MORE TURNS PER MOLD***

Faster, more economical and therefore more *profitable* shaping, bagging and curing of passenger and truck tires is made possible with the Model E 40″ Packless Autoform Vulcanizer. Extremely simple in construction and method of operation, it cuts maintenance costs to bare minimums, and makes bladder assembly and mounting six times faster than with rod type presses. Up to 68 turns per mold is regularly obtained in 24 hours with automatic unloading on present day cure cycles.

Fully versatile, the 40″ Autoform handles all passenger tire sizes. Complete with all controls and instruments, it is ready to operate when connected to electricity, air and steam. Neither hydraulic nor vacuum service is required. Compactly designed, it requires 15% less floor space than other types of vulcanizers.

Autoforms are currently available in 40″ dual platen and 45″, 50″ and 55″ dual platen and dome types.

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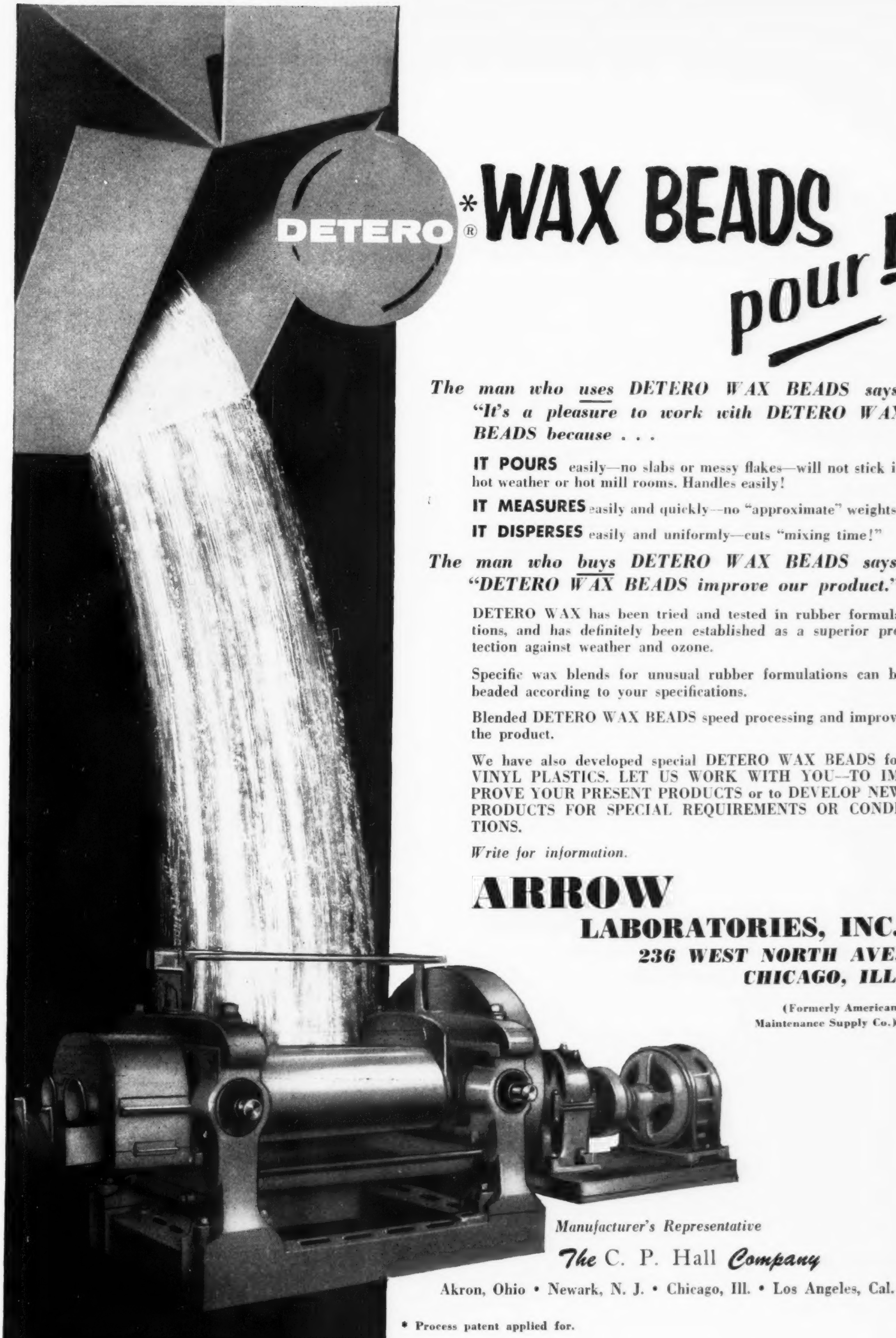
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The man who uses DETERO WAX BEADS says, "It's a pleasure to work with DETERO WAX BEADS because . . .
IT POURS easily—no slabs or messy flakes—will not stick in hot weather or hot mill rooms. Handles easily!
IT MEASURES easily and quickly—no "approximate" weights!
IT DISPERSES easily and uniformly—cuts "mixing time!"
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DETERO WAX has been tried and tested in rubber formulations, and has definitely been established as a superior protection against weather and ozone.
Specific wax blends for unusual rubber formulations can be beaded according to your specifications.
Blended DETERO WAX BEADS speed processing and improve the product.
We have also developed special DETERO WAX BEADS for VINYL PLASTICS. LET US WORK WITH YOU—TO IMPROVE YOUR PRESENT PRODUCTS or to DEVELOP NEW PRODUCTS FOR SPECIAL REQUIREMENTS OR CONDITIONS.
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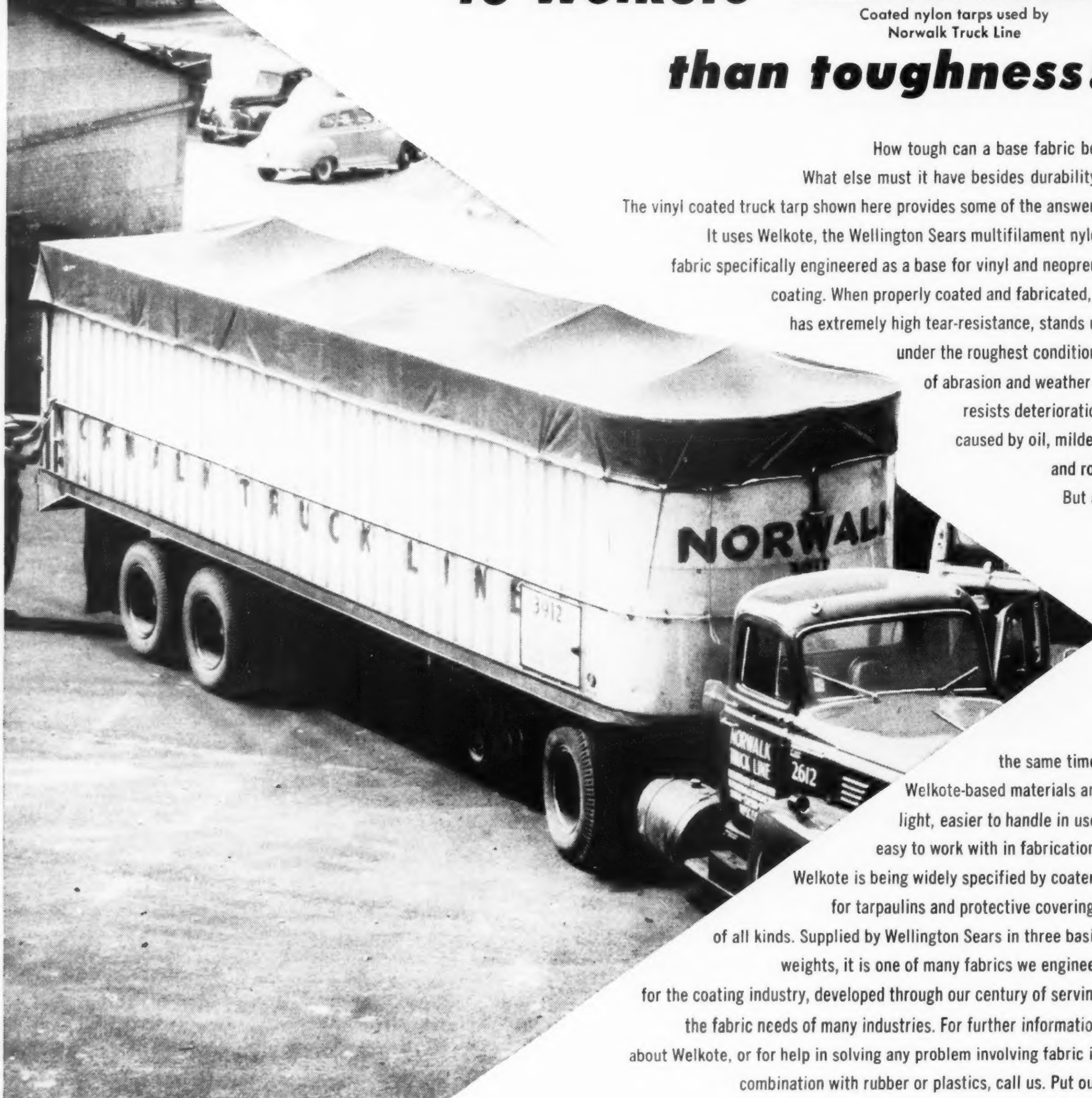
* Process patent applied for.

There's more to Welkote than toughness!

Coated nylon tarps used by Norwalk Truck Line



How tough can a base fabric be? What else must it have besides durability? The vinyl coated truck tarp shown here provides some of the answers. It uses Welkote, the Wellington Sears multifilament nylon fabric specifically engineered as a base for vinyl and neoprene coating. When properly coated and fabricated, it has extremely high tear-resistance, stands up under the roughest conditions of abrasion and weather—resists deterioration caused by oil, mildew and rot. But at the same time, Welkote-based materials are light, easier to handle in use, easy to work with in fabrication! Welkote is being widely specified by coaters for tarpaulins and protective coverings of all kinds. Supplied by Wellington Sears in three basic weights, it is one of many fabrics we engineer for the coating industry, developed through our century of serving the fabric needs of many industries. For further information about Welkote, or for help in solving any problem involving fabric in combination with rubber or plastics, call us. Put our experience to work for you. For informative booklet, "Modern Textiles for Industry," write Dept. H-3.

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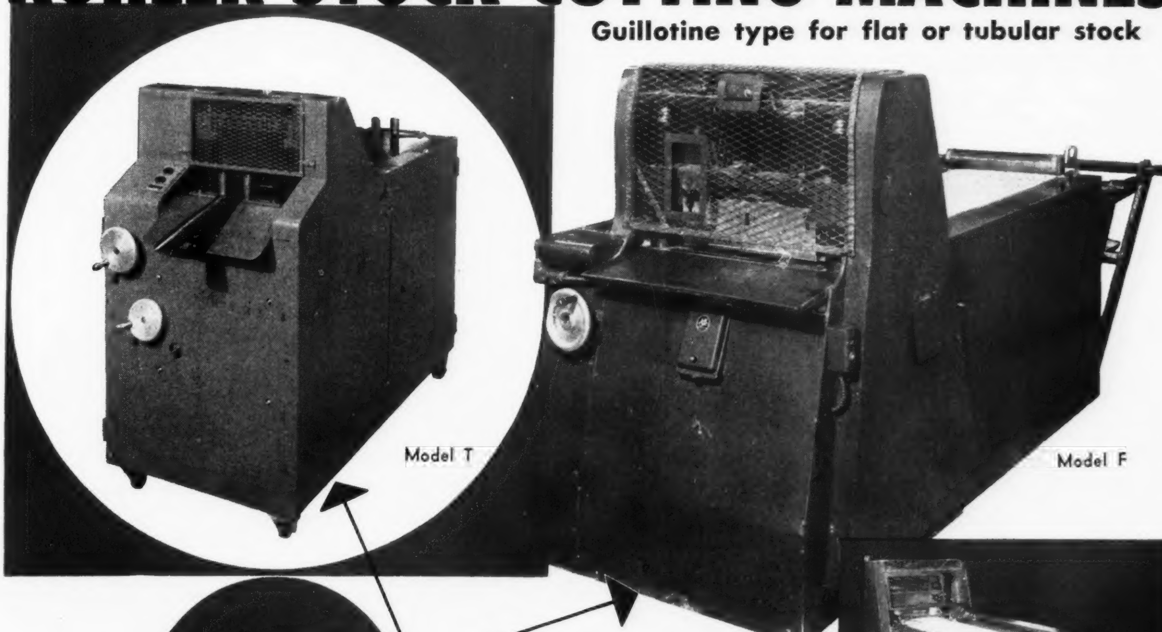
KOHLER STOCK CUTTING MACHINES

Guillotine type for flat or tubular stock



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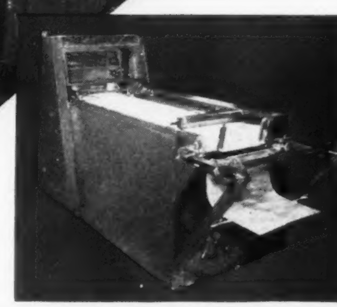
SYNCHRONIZED POSITIVE MECHANICAL DRIVE

ADJUSTABLE WHILE IN MOTION

Model F machine for calendared or flat stock. Built in conveyor. Pivoting blade available for diagonal cuts.

Model T machine. Use with tubing machine or like. Continuous feed.

These machines can be seen in operation, anytime. Call for appointment.



Rear view of Model F machine.

THERE IS NO MACHINE ON THE MARKET WHICH CAN CUT WITH THE ACCURACY OF KOHLER MACHINES.

KOHLER CUTTERS FEATURE

- Continuous feed
- Handles flat or tubular stock, cured or uncured
- Dual feed, top and bottom surface contact
- Compensated take-up to handle any thickness
- Will accommodate extruded, milled, calendared, or most any stock
- Adjustable speed and cut length, in motion
- Available with switch blades for alternate diagonal cuts
- Available with roll feed, belt feed, or both
- Vernier controlled adjustments
- Models and sizes to handle any job

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In their brief but exciting history, chelating agents have encountered reactions ranging from scoffs and disbelief to overzealous exaggeration about their application. But the air is clearing. Already they are serving as important tools in many industrial processes. This is the beginning of a series on chelating agents designed to further clarify what they are, what they will do—and won't do.

The Chemistry of Chelation: Part I

Chelation defined · Example of the reaction · Variety of applications · Future of chelating agents

Polymerization of synthetic rubber controlled . . . soap kept white and sparkling on the dealer's shelf . . . textiles bleached and dyed with permanent uniform colors . . . pharmaceuticals stabilized. Unrelated reactions? Certainly. However, all are accomplished by a group of closely related chemicals called chelating agents. How do they work? Well, it's not magic, but chemistry—in a way, fairly basic chemistry. But let's begin at the beginning.

What Is Chelation?

Let's look at the word chelation. It is derived from the Greek word *Kelos* which means "claw." Simply stated, a chelate is a claw which holds a metallic ion inactive in solution. Chemically stated, chelation is a chemical reaction in which polyvalent metallic ions are reacted with organic reagents (chelating agents) to chemically inactivate these polyvalent metallic ions in the form of an extremely stable, water-soluble chelate.

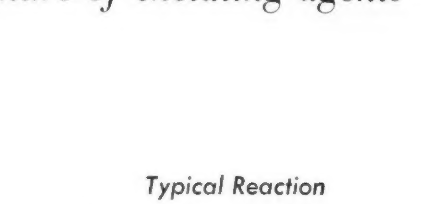
Typical Reaction

If we examine a typical reaction, the process of chelation becomes quite clear. Let us take, for example, the chemical structure of Versene®, one of the Dow chelating agents.

Versene

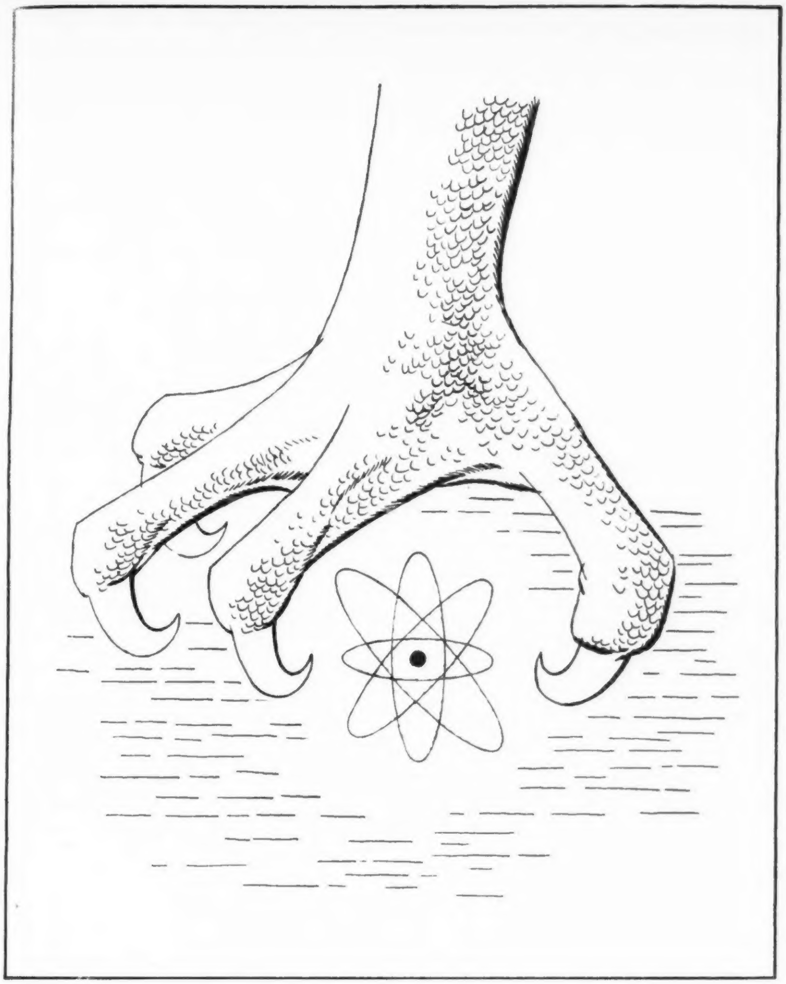
Now, if we place the Versene in a solution which contains free polyvalent ions of copper (Cu^{++}), the following is the result:

plus Cu^{++} gives



Versene Copper Chelate

The resultant compound is Versene copper chelate. The copper ion has become a member of an inner ring structure in the molecule. The result?



They can descale boilers, soften water and cure acute lead poisoning. The number of current industrial and medical applications is large, but the potential in unexplored areas is enormous.

And the Future?

The future of these products will hinge on the imagination and insight of chemists and engineers, of production men and purchasing agents, in nearly every industry. Wherever metal contamination poses a problem or wherever controlled introduction of metal ions is desirable, these chemicals warrant investigation.

Versene and other Dow chelating agents won't solve them all. Chelation is not a panacea. It will work chemically in some areas—it will fail in others. However, it is Dow's intention to assist in every way in the uncovering of processes in which chelating agents can be profitably used. Inquiries on your company letterhead will be handled with dispatch. We will be pleased to provide information and technical assistance. Write to Technical Service and Development, Dept. SC 900N, THE DOW CHEMICAL COMPANY, Midland, Michigan.

It is inactivated. It cannot react with soap to cause darkening and stain during storage.

It can't cause breakdown of pharmaceuticals. It can't cause any trouble anywhere because it is locked in the Versene claw. It will stay locked in unless it is desired to reverse the process. This reverse action is used in polymerization of synthetic rubber—ions of iron being released at a predetermined rate by the chelate.

Variety of Applications

The most important thing, however, is that this "claw" property of chelating agents such as Versene makes it possible to solve a multitude of processing problems in industry. They've been used in tanning leather and tenderizing peas.

The next two topics in this series

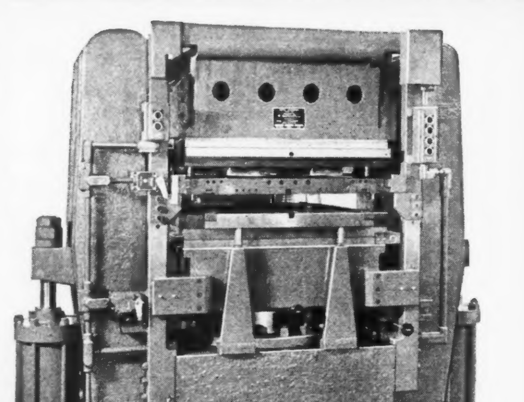
PART II April	The Versene and Versenol® series of Dow chelating agents (what they are, strength and stability features—Versenol lower cost, less strength). Also—how chelating agents are specified (product performance versus chemical composition).
PART III August	Specific chelating agents for specific applications. Polymerization of synthetic rubber (development of Versene Fe-3 for controlled release of traces of metal used as catalyst—improvement in process that results).

you can depend on DOW CHEMICALS DOW

"A" can be adjusted to any requir
opening by setting limit of ram travel

"B" and "C" openings can be adjust
by movement of intermediate platen
transfer mol

NOW



Above photo is a two deck or two opening press. However, the intermediate platen is a transfer mold and the plunger plate replaces the usual mold fastened to tilting head.

The tilting head design is not new. There are many tilting heads in operation with service records of 15-20 years. However, the two opening design is new.

ONLY THE MATERIAL MOVES IN AND OUT

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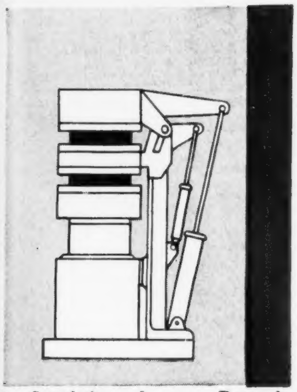
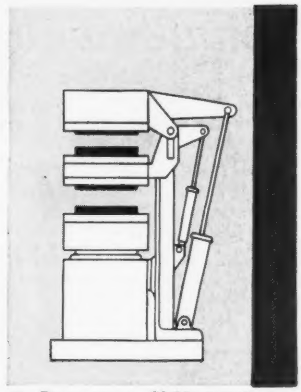
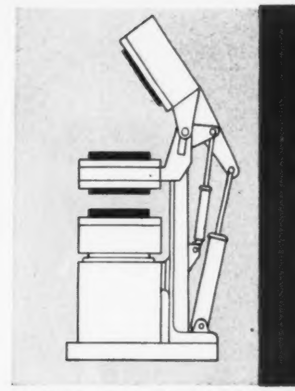


1. Completion of cure. Press is ready to open.

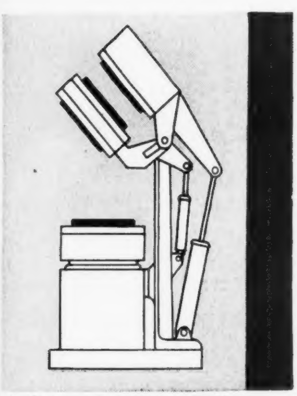


2. Press opens. Molds remain parallel during entire stroke of ram. This is necessary for deep cavity molds.

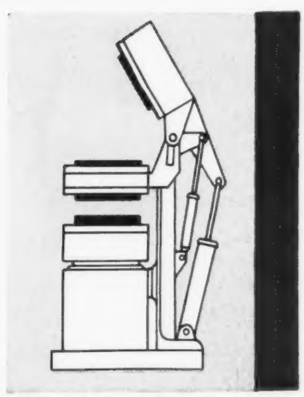


3. Head tilts back, exposing two halves of mold in top deck--cured articles are removed.

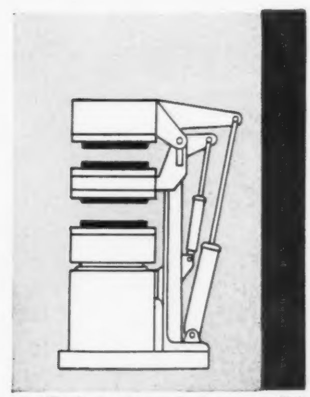
A TWO-OPENING TILTING HEAD PRESS



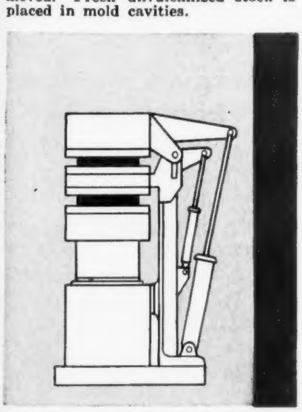
4. Intermediate platen tilts back, exposing two halves of mold in lower deck. Cured articles are removed. Fresh unvulcanized stock is placed in mold cavities.



5. Intermediate platen lowers into parallel position — unvulcanized stock is inserted in mold cavities.



6. Head is lowered into parallel position.



7. Ram travels upward and closes press. DIRECT AND FULL PRESSURE OF HYDRAULIC SYSTEM IS AVAILABLE THROUGHOUT ENTIRE STROKE OF RAM.

- Only the material moves in and out of the press. Molds remain in press, therefore mold halves **stay in register.**
- Cures two sets of molds at the same time.
- Timer, at prescribed intervals, automatically raises and lowers the ram, tilt head and intermediate platen.
- One operator, male or female, can attend to approximately as many presses as there are minutes in cure time. The operator simply removes cured articles and replaces with uncured, pre-formed stock.
- Press Sizes: 24-32-36"—up to 1,000-ton pressure.
- Two Opening Press can be used as a single opening press for extremely deep molds.

)F THE TILTING HEAD

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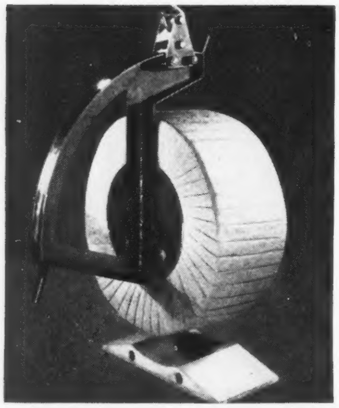
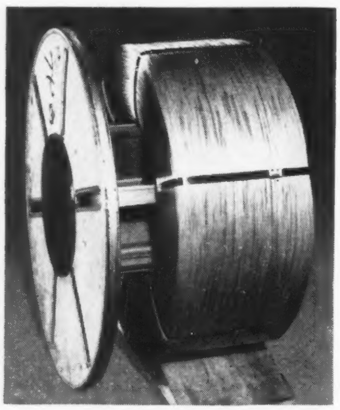
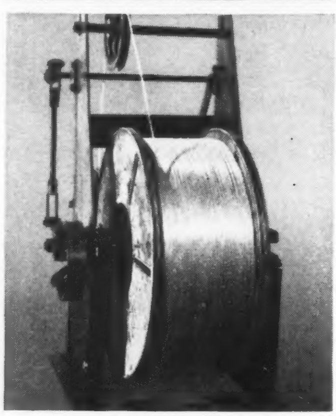
MANUFACTURED B

THE AETNA-STANDARD ENGINEERING CO., PITTSBURGH, PA.







Pneumatic coil lifter positioning reelless coil over saddle block prior to removal of paper wrap and assembly of let-off reel.*

Partly assembled pneumatic let-off reel. Note provision for removal of steel strapping and easy assembly of reel to coil on saddle block.*

Completely assembled reel with bead wire coil mounted on conventional let-off stand.

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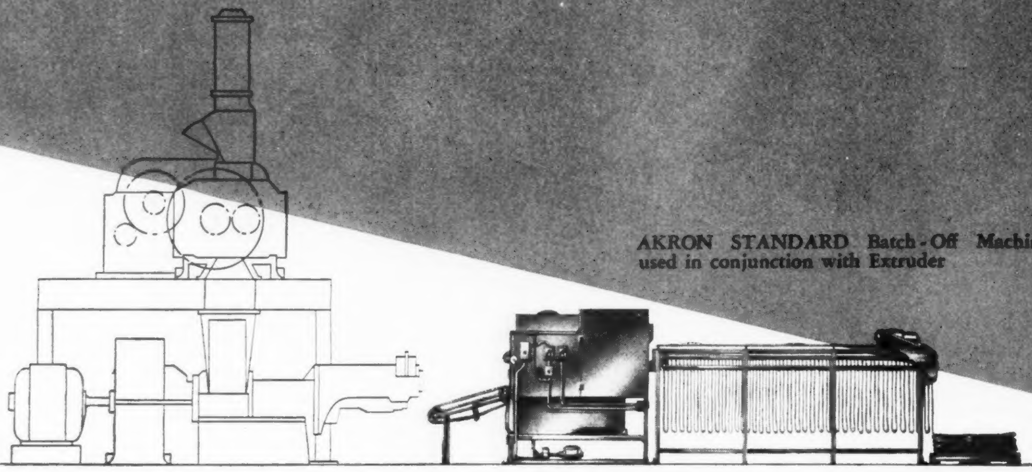

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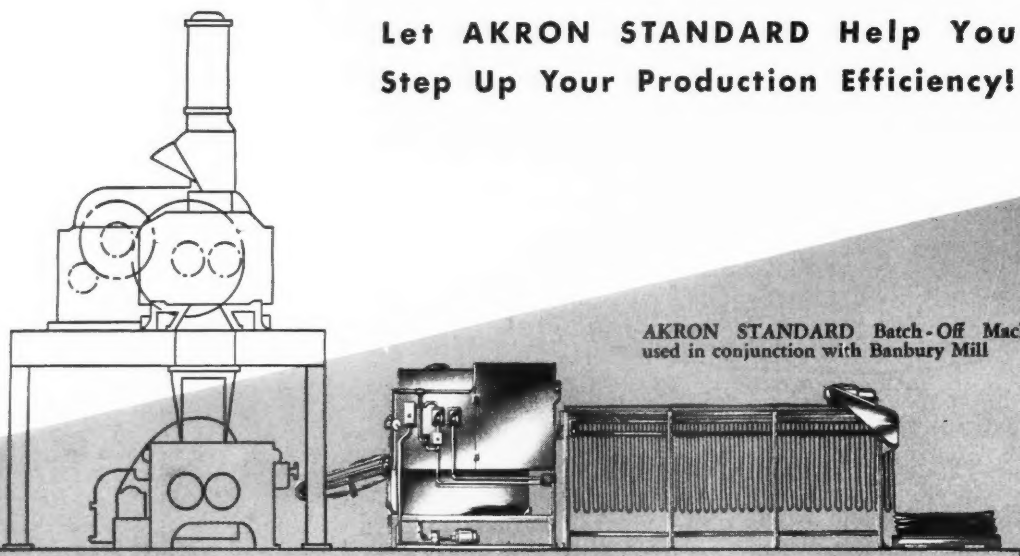

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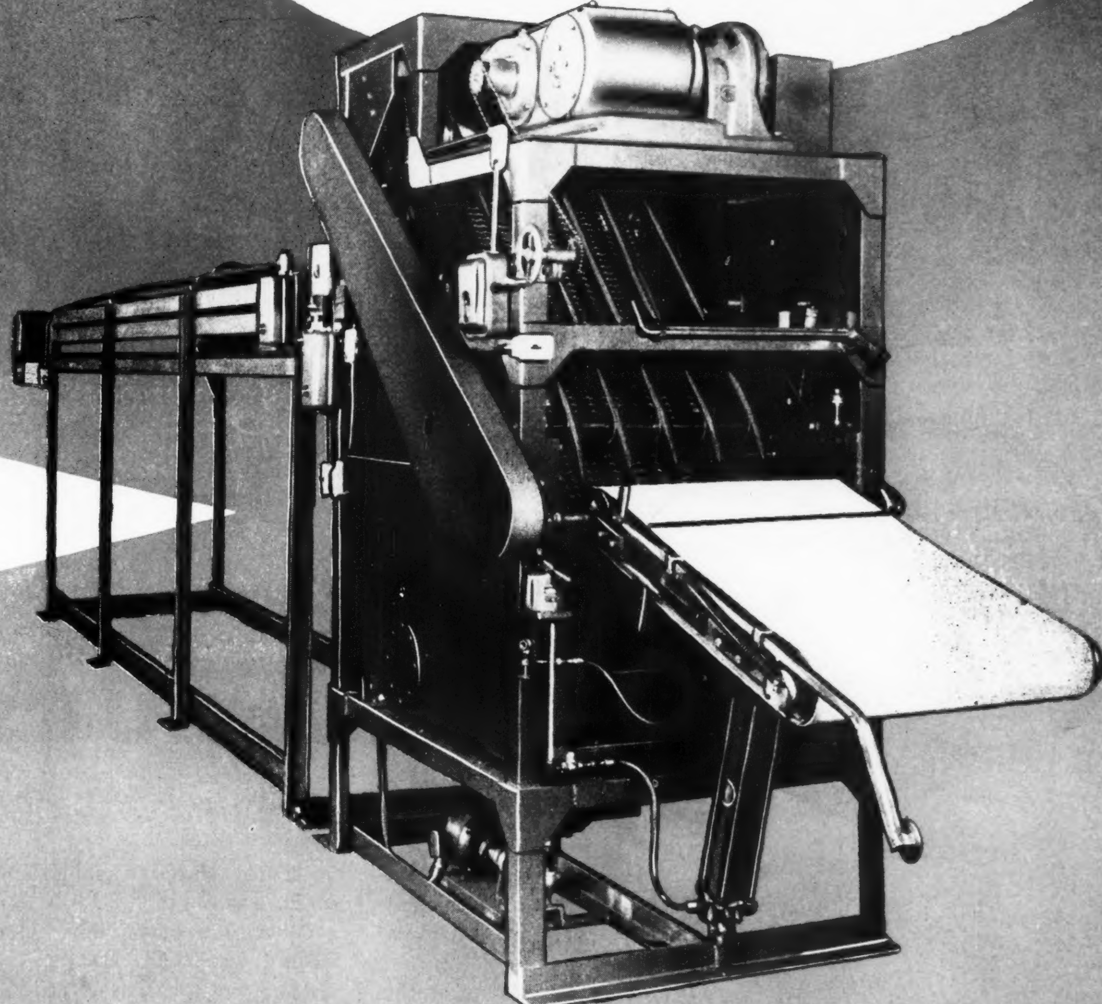

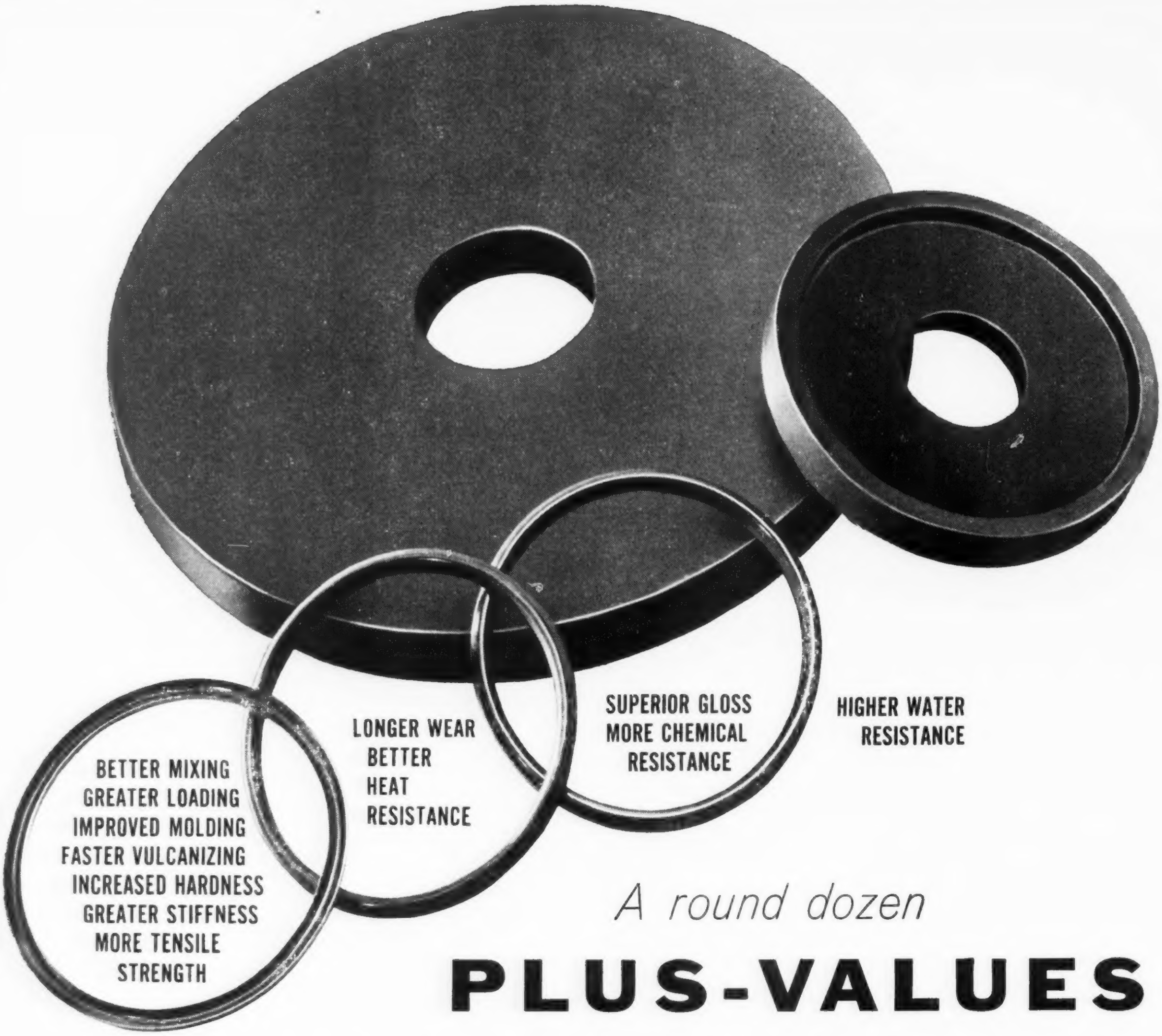

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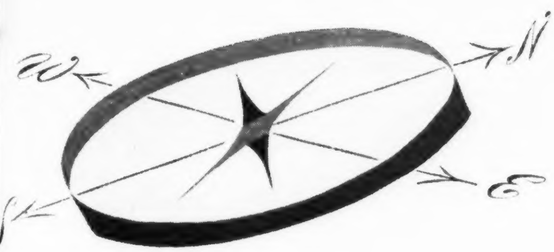
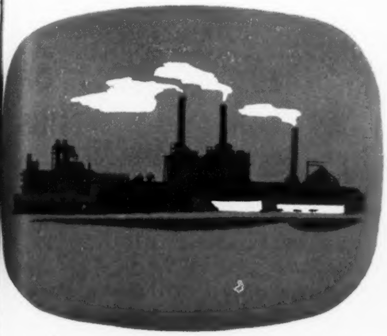
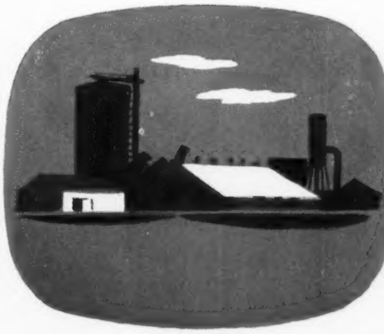




Sunray, Texas



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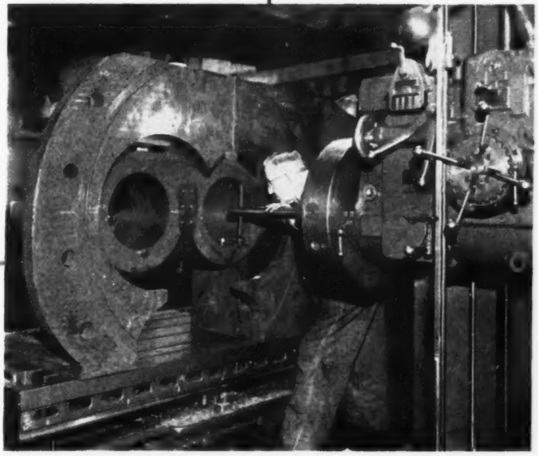
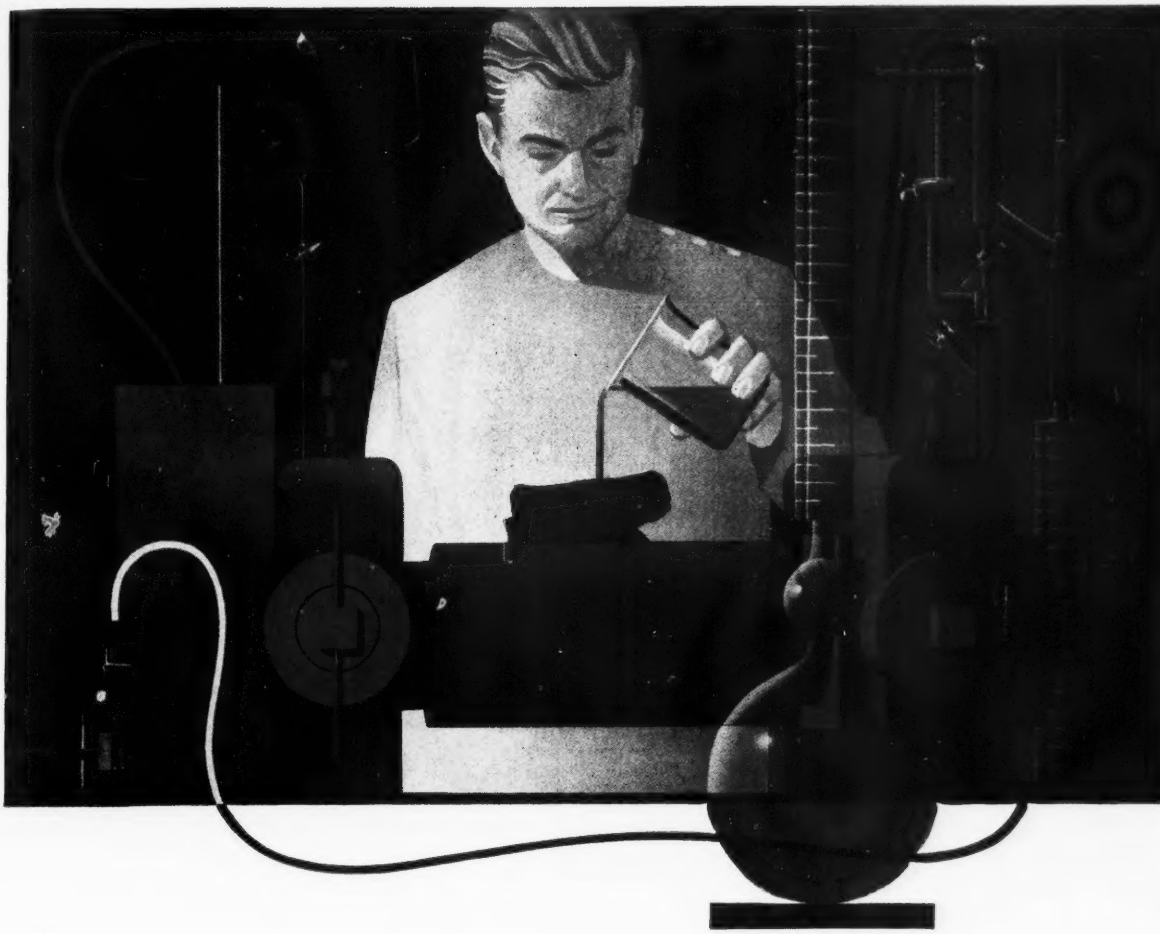


Precision inspection preparatory to restoration to standard dimensions.



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RUBBER WORLD

MARCH, 1956

James E. Gaughan

Ozone Cracking of Natural and Synthetic Rubbers[1]

By JAMES E. GAUGHAN
Detroit Arsenal, Center Line, Mich.

That phase of rubber deterioration previously described as weather- or sun-checking has now been established as due largely to one cause, ozone attack, which has a definite adverse effect on the performance and durability of rubber products used by the Ordnance Department, U. S. Army, and elsewhere.

Basic and applied research done under government sponsorship in cooperation with industry have developed chemical antiozonants to GR-S type synthetic rubbers to an extent not hitherto thought possible.

Improved specifications for rubber products for military use are being issued which will result in lower overall cost for such products and greater reliability when used.

RUBBER must in many respects be considered a perishable item. Since the amount of taxpayers' money tied up in military rubber items is counted in many millions of dollars, and since the lives of military airmen, and the security of the country, often depend on the reliable performance of rubber items long in storage, a conference on rubber deterioration was held by the National Research Council, Washington, D. C., on September 29, 1953 (1).[2] In this conference the various agencies of the Department of Defense who were seeking advice and guidance presented problems in rubber deterioration and the logistic implications thereof to a select panel drawn from the National Research Council and the rubber industry (2).

[1] The opinions or assertions contained herein are not to be construed as official or reflecting the views of the Department of the Army.
Presented at a meeting of the Division of Rubber Chemistry, ACS, Detroit, Mich., May 6, 1955.
[2] Numbers in parentheses refer to Bibliography references at end of article.

The most definite and disturbing result of this conference was the universal lack of comprehensive knowledge about the deterioration of natural and synthetic rubbers. Many changes in the condition of elastomers were known to take place. They could oxidize, polymerize, depolymerize, cross-link, revert, weather crack, craze and chalk, harden, stiffen, continue to cure, flex crack, blow out, chip, separate, wear off, etc. This paper will take up only one of these changes, that is, ozone cracking.

O_3 Formation and Atmospheric Concentration

What is ozone? How is this small but potent rubber destroyer formed? Ozone is a special form of oxygen. Ordinary oxygen is composed of molecules containing two atoms of oxygen. By adding certain quanta of the minimum or greater energy (3-5) three atoms of oxygen can form a very reactive, unstable molecule of oxygen called ozone. The characteristic odor of ozone

can often be detected near electric motors or generators. The energy to create this ozone comes from the arcing of the commutator.

Except for the ozone formed by the smog type of reaction as described recently by A. J. Haagen-Smit (6), California Institute of Technology, ozone molecules which crack exposed rubber items come mostly from nature. Light from the sun in the extreme ultra-violet range of the spectrum strikes layers of almost pure oxygen between 18 and 45 kilometers (approximately 60,000 to 140,000 feet) above the earth and is absorbed, thus supplying the necessary amounts (quanta) of energy to convert it to ozone (7). These ozone molecules form a layer of air having a very high ozone content, and this ozone is carried from the stratosphere to the earth's surface by the turbulence of the troposphere (the part of the earth's atmosphere in which our normal weather phenomena take place). Cyclones, anti-cyclones, jet-streams, and other aspects of weather carry the ozone to the surface of the earth where contact with organic materials and dust causes it to decompose into normal oxygen (8).

No ozone is generated by the sun's ultra-violet light below 15 kilometers (approximately 40,000 feet). In fact, all of the high ultra-violet band below 2900 Angstroms wave length (9) is absorbed before it reaches the earth. Thus the ozone concentration at the surface of the earth is as changeable as the weather of which it is a function. It is borne by the wind and absorbed by some surface areas, but not by others. The quantity of ozone at the Detroit Arsenal varies from a trace to approximately 12 PPHM (10). Los Angeles, Calif., (11-13), has reported ozone maxima up to 50 PPHM. Pasadena, Calif., has reported ozone maxima up to 80 PPHM (14). Ozone for laboratory tests is generated by ultra-violet lights having special glass envelopes (15) or by electrical discharge.

History of Ozone Attack on Rubber

In 1885 it was noted that ozone acts more rapidly on stretched than on unstretched rubber. About 1926 (16) Williams took the view that rapid surface cracking of stretched rubber under ultra-violet light was due to the ozone formed, and he mentioned that such cracking was obtained *in the dark* in an atmosphere containing ozone. Around 1930 (17) it was found that maximum ozone cracking occurred at 10% elongation. About 1931 (18) Van Rossem and Talen confirmed the fact that ozonized air produces the same cracks that occur in vulcanized rubber exposed to the open air and sunlight. They also stated that antioxidants had little effect in preventing ozone cracking. Around 1934 (19) Turner demonstrated that "sun cracking" was not due to absorption of light waves, but was produced on stretched rubber shielded from light and was attributable to ozone. Turner also showed that absorption of certain light waves could lead to an oxidized skin which afforded some protection against ozone.

Based on the information mentioned in the preceding paragraph, several tests of ozone (and also electrical corona) resistance were tried; the most widely known was that developed by Crabtree and Kemp at Bell Telephone Laboratories (20), the results of which were published in 1946. This work eventually led to the ASTM D1149[3] accelerated ozone test method.

In recent years very extensive work has been accomplished through Rock Island Arsenal Ordnance contracts with the Firestone Tire & Rubber Co. (21). In these studies synthetic as well as natural rubbers were tested. This work included studies of the effects of elongation, ozone concentration, antioxidants, temperature, humidity, various bands of light, prior oxidation, dynamic and static exposure, and all other known variables in the ozone picture. A good summary of the results to date is contained in the following sentence from a Firestone article in India RUBBER WORLD (22):

"Ozone is the prime cause of weather checking of rubber with light, heat, and moisture being contributing factors of secondary importance."

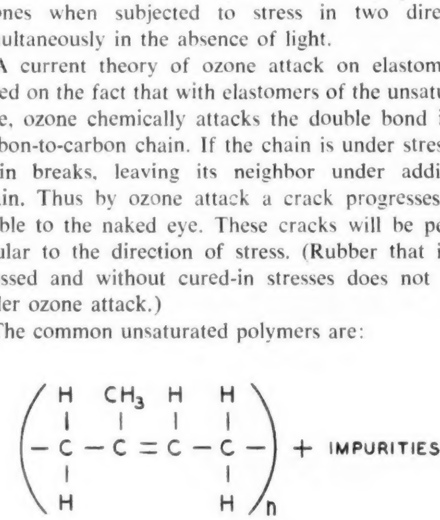
Several of the other major tire companies, such as United States Rubber Co. (23, 24), Lee Rubber & Tire Corp. (25), and Gates Rubber Co. (26), have also published articles on ozone attack. The work done on the ozone problem by personnel in the mechanical rubber goods industry, as well as an excellent summary of the whole ozone problem, was published by H. A. Winkelmann, former chairman of the SAE-ASTM Technical Committee on Automotive Rubber (27). This presentation of the development of information about *ozone* attacks on rubber is by no means complete, but it will serve as a skeleton outline of *some* of the important progress steps.

Theory of Ozone Attack

From the foregoing information, it can be seen that the "sun checking" of rubber is definitely tied to ozone and is not a phenomenon due to light. Formerly, a type of checking in small squares often seen on tire sidewalls was considered "sun checking." This last remnant of the old theory was blasted by Z. T. Ossefort and W. J. Touhey, of the Rock Island Arsenal Laboratory in April, 1955 (28). Such crack patterns were produced by ozones when subjected to stress in two directions simultaneously in the absence of light.

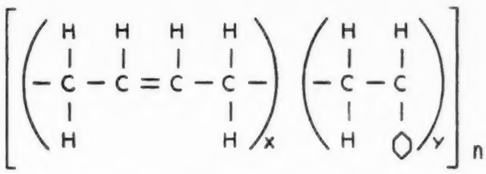
A current theory of ozone attack on elastomers is based on the fact that with elastomers of the unsaturated type, ozone chemically attacks the double bond in the carbon-to-carbon chain. If the chain is under stress, the chain breaks, leaving its neighbor under additional strain. Thus by ozone attack a crack progresses until visible to the naked eye. These cracks will be perpendicular to the direction of stress. (Rubber that is unstressed and without cured-in stresses does not crack under ozone attack.)

The common unsaturated polymers are:



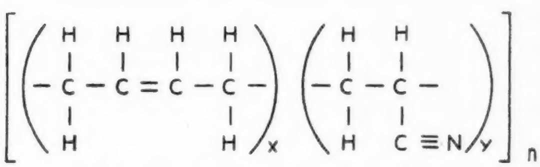
Natural Rubber

[3] American Society for Testing Materials, Philadelphia, Pa.



Butadiene-Styrene Synthetic Rubber

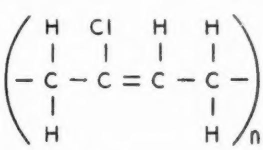
Ratio of X to Y usually from 70/30 to 100/0%



Butadiene-Acrylonitrile Synthetic Rubber

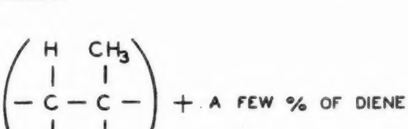
Ratio of X to Y from 60/40 to 82/18

Although neoprene is unsaturated, apparently the presence of the chlorine atom near the double bond makes this polymer quite weather resistant:

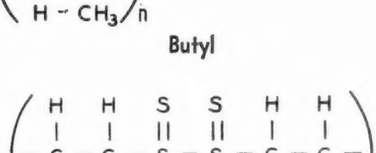


Neoprene

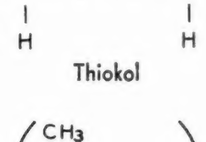
Butyl, Thiokol, and silicone polymers are saturated and, if properly compounded, are highly resistant to ozone attack:



Butyl



Thiokol



Silicone

Ozone Cracking and Service Life

We have seen what ozone cracking does to rubber polymers. What does this mean to the end-items used by Ordnance? Some failures are clear cut, for instance, the vacuum hose to windshield wipers on trucks, which cracked entirely through. (See Figure 1.) The extent of the seriousness of ozone cracking on certain items, such as wiring and tires, is controversial. It is the view of the industry that such cracks, which may appear visible in a few days or weeks, are detrimental to appearance, but not to performance. Tests conducted by Detroit Arsenal (29), and the experience of various Ordnance (30) and Transportation Corps Officers (31) indicate that this evaluation is true, but with definite qualifications. Low speed, low load operations, training maneuvers, and tests on tires of limited crack depth or age indicated no serious trouble. However, sustained operations at high loads and speeds on old tires cracked to fabric gave very early and severe failures (32-34).

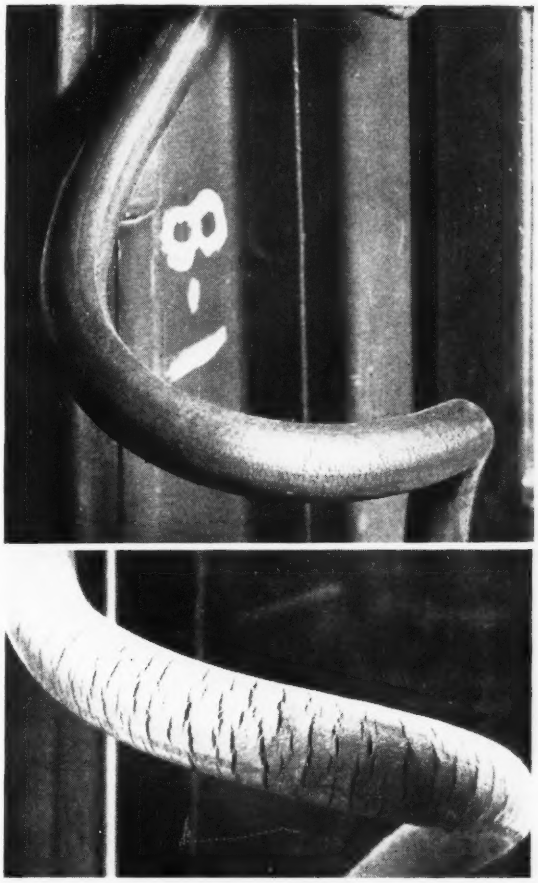


Fig. 1. Windshield wiper hose on vehicle at Camp Bullis, San Antonio, Tex. Installed March 17, 1955, and photographed April 18, 1955 (top). Same hose (bottom) after further exposure, May 18, 1955, to July 29, 1955, Pasadena, Calif.

In addition to the above tests there has been a history of ozone problems on farm tractor tires, passenger-car tires, and truck tires held in storage for a long period before sales. While a belief is held that ozone cracking on nitrile rubber or low neoprene-rubber content blends in AXS-1819 (35) low-tension cable sheaths in Ordnance vehicles has not led to service failures, the writer

would seriously doubt the cracked wire's reliability in salt water amphibious operations or wet climates, or after longer storage and deterioration. Deep cracking of radiator hose covers prompts serious doubts as to their serviceability in rough going. This is also true of a great host of other mechanical rubber goods such as AXS-1659 electrical grommets (36), turret seals, bus-door flaps (Figure 2), weather stripping, etc.

Certain items of ozone-resistant polymers, have, on the other hand, given excellent weather resistance. Examples are MIL-C-13486 (37) *neoprene* sheath low-tension cable, brake hose, butyl inner tubes, etc.

Methods for Improving Ozone Resistance

What can be done about ozone attack? One obvious answer is to go to ozone resistant polymers. Unfortunately this is not always possible. Tires, the biggest users of rubber, are made for Ordnance principally from the unsaturated GR-S type polymer. Neoprene tires were attempted without much success during World War II's dark days of rubber shortage. In the hope that newer techniques might make neoprene tires possible, a new contract was let to attempt this (38). Indications, however, were that the separation of tread and plies and the high cost of neoprene or suitable neoprene blends (above 60%) still made this approach unfeasible.

Butyl tire development, as well as proper latex dips (39) for plies used therein, is now under way (40), but the results will not be known until some future date.

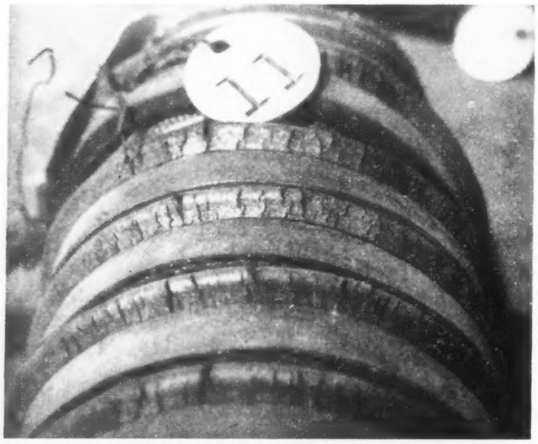


Fig. 2. Sponge door seal on mandrel (top) and sponge rubber on door at latch of vehicle after exposure at Pasadena, Calif., May 18, 1955, to August 19, 1955

Fig. 3. Example of peeling of vinyl coating from tire during storage and exposure for 17 months

In regard to the studies on butyl tires, Standard Oil Development Co.[4] personnel (41) feel that a butyl best suited for tires might be considerably less ozone resistant than currently used butyls. Sometimes high oil resistance and extreme low-temperature requirements make the use of unsaturated nitrile polymer necessary. Conversely, expensive, moderately oil resistant neoprene may have to be specified where less oil resistance is required, but it is desired to take advantage of the inherent weather resistance of this polymer. Thus ozone resistant polymers are an excellent available solution to the ozone problem where they can be used feasibly, but their use is not always technically or economically possible.

Present practice for preservation of tires calls for spraying with a vinyl coating (42). However the experience of Detroit Arsenal (43) and Rock Island Arsenal where much work on coatings has been performed (44), indicates that vinyl-type coatings harden (probably owing to plasticizer migration into tire) and bubble (45) (probably owing to gradual air seepage from inflated tire—Figure 3). Also, these coatings are not suitable either for stripping or running dynamically, and they are very costly and require special equipment to apply. Neoprene and similar sprays (MIL-C-11520A) (46) seem to lose much of their original effectiveness after about one year due to pin holing, peeling, etc., but they can be used in limited dynamic application where vinyl coatings cannot.

Antiozonants

The best approach to ozone protection lies with chemicals compounded into the rubber stock before the end-item is made. Waxes have been used in many non-dynamic or semi-dynamic mechanical rubber items for years, but waxes increase rather than decrease cracking tendency in most dynamic applications of rubber. The rubber industry has for many years used chemicals compounded into rubber to give protection against conventional oxidation and heat aging effects. The name antioxidants was given to these chemicals. Over a period of years after World War II the Rock Island Arsenal Rubber Laboratory conducted and also contracted (47, 48)

[4] Now known as Esso Engineering & Research Corp., Linden, N. J.

a basic inquiry into deterioration of rubber, including cracking.

The first major advance resulting from the work aimed at eliminating the cracking of rubber goods was to discard the "sun checking" theory and proving this cracking to be specific to ozone. The second major advance was the discarding of conventional antioxidants as the remedy.

Ozone, while composed of oxygen atoms, is not a brother, but rather a vigorous, individualistic cousin of conventional oxygen. Ordinary antioxidants give protection against ozone cracking mostly by accident, the same way they might also accidentally behave as an accelerator. In fact, a detailed study of the effect of conventional antioxidants against ozone attack gave results ranging from good protection to definitely harmful effects (49). [Conversely some good protectors against ozone give very detrimental effects on conventional heat aging (50).] Thus a new material was needed, an antiozonant, i.e., a chemical additive specifically developed to prevent ozone attack.

A third major advance was the discovery by Rock Island Arsenal that an antioxidant for gasoline, N,N′, disecondary butyl paraphenylene diamine [Tennessee Eastman's Tenamene II (51); Universal Oil Products No. 5], was an excellent antiozonant for rubber. This material had two defects, however; it was toxic and somewhat fugitive. As a result of further work at Rock Island Arsenal, N′,N′ disecondary butyl benzidene was developed. This antiozonant overcame much of the toxicity and many of the high vapor pressure problems (52). However this chemical seems to be difficult to manufacture, and it is limited by availability and cost of raw materials. By continued research, Rock Island Arsenal Laboratory (53) and its contractor, Augustana College, have developed a general class of amine-type antiozidants.

Simultaneously, Burke Research Co. (54), under Detroit Arsenal Contract, investigated empirically a wide range of chemicals for antiozonant properties in GR-S type synthetic rubber. Among others, N,N′ di-octyl-paraphenylene diamine, N,N′ di-nonyl paraphenylene diamine, and Bayer Antioxidant 4010 were found to be excellent antiozonants with low toxicity and volatility. Two of these materials are already in production, although the cost is moderately high.

Research is continuing both with a basic approach at Rock Island Arsenal and with an empirical approach at Detroit Arsenal to find additional, cheaper antiozonants and determine their effectiveness in polymers other than GR-S type rubber. Natural rubber (55) appears to require a higher loading of antiozonant than GR-S type rubber for equal protection.

Present Ordnance Preventative Program

What is being done about ozone attack on Ordnance rubber end-items? Three proprietary antiozonant constructions, Tenamene II (only 1.1 parts per hundred rubber hydrocarbon), and Santoflex AW[5] (1.5 parts per hundred rubber hydrocarbon) have been tested for more than three years' exposure at Detroit Arsenal (56), Rock Island Arsenal, Yuma Test Station (57), San Antonio, Tex. (58), and Big Delta, Alaska (59). Parallel fleet tests have been run at all sites except the Arsenals. Results of these tests are a basis for future work. The newer antiozonants have been built into tires, fleet tested (60), and are on extended outdoor storage in various parts of the United States, including such localities as Pasadena, Calif., where ozone concentration in the atmosphere is notoriously high.

Since 1951, numerous unsatisfactory equipment reports have been received on early and severe weather cracking of tires, mechanical rubber goods, and wire insulation. The companies whose products have been below the industry average in ozone resistance have often voluntarily improved the quality of their product upon notification of its defects and the seriousness thereof. The major problem is that the industry average quality of rubber items produced for Ordnance still falls far short of the real requirements. This situation is due to the inherent properties of unsaturated polymers used without antiozonants and failure of use ozone-resistant polymers where possible.

To bring about procurement of better products, the "C" (weathering) suffix used in MIL-R-003065 (61) general specification of rubber compounds has been specifically defined, and tests have been established. Specification MIL-C-13486 (37) for vehicle wiring has been issued to eliminate the widespread cracking experienced. Similar action is in progress on radiator hose and many other mechanical items. In coordination with the tire industry, an engineering change order to the Ordnance tire specification MIL-T-12459 (62) has been issued to require ozone resistance.

Figure 4 indicates the relative performance of old and new-type tire compounds in an accelerated test. The complete tire was exposed to 30 parts per hundred million ozone for 60 days. The uncracked portion contains three parts of an antiozonant and one part wax. The control section was made of regular production compound.

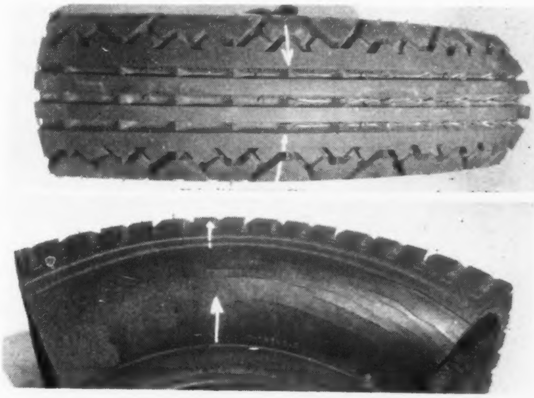


Fig. 4. Tire (tread, top; sidewall, bottom) exposed to 30 PPHM of ozone for 60 days. Left, portion of tire made with compound containing three parts antiozonant plus one part of wax; right, portion of tire made with standard compound

[5] Monsanto Chemical Co., Rubber Chemicals Department, Akron, O.

Summary and Conclusion

To summarize briefly, that phase of rubber deterioration earlier described under the broad term "weather checking" has now been tied down largely to one cause, *ozone* attack, which has a definite adverse effect on the performance and durability of rubber items used by the Ordnance Department, U. S. Army.

Through basic and applied research by government laboratories in cooperation with industry, chemical antiozonants have been developed which impart ozone resistance to GR-S type rubbers to an extent not hitherto thought possible.

Improved rubber component and vehicle specifications are being issued which result in lower overall cost and greater defense reliability.

The author wishes to express his appreciation to the Department of Defense for permission to publish this paper.

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Research Stepchild of U. S. Foundations

Of the $164,000,000 spent by the 77 largest philanthropic foundations in the United States during 1953, only $26,000,000, or 19.8%, went for scientific research. This is about 0.5% of the estimated national total for all research and development spent in that year. Of the 77 foundations, only 43 reported expenditures for scientific research. These facts have been reported by the Russell Sage Foundation, which surveyed American philanthropic expenditures for 1953.

Rubber Product Clues—Aid to Justice

By D. J. PARSONS[1]
Federal Bureau of Investigation, Washington, D. C.

The FBI Laboratory in Washington, D. C., maintains a Shoe Print File and a Tire Tread File for its own use and the use of the rest of the nation's law enforcement agencies. The Shoe Print File, originated in 1937, is a collection of more than 2,700 different designs of rubber and composition heels and soles, together with other significant data. The Tire Tread File, first begun in 1932, contains blueprints, photographs, and literature of more than 2,000 different tire designs, American and foreign, as well as recap and retread patterns. Both are maintained through the cooperation of footwear and tire manufacturers, and the V. L. Smithers Laboratories on tread patterns. In 1954, FBI Laboratory experts conducted more than 540 examinations of rubber product clues with these files.

Fig. 1. Heel impression in rubber lost by bank robbery suspect, *left*, and photograph of heel of shoe worn by him, *right*

THE vital place of rubber in industry, transportation, the laboratory, and the home is familiar to everyone. Its use as an aid to law enforcement is not so well known. Such simple things as the impressions made by tire treads or shoe heels may trap a killer or tie a burglar to his crime. Even the mark left by a rubber stamp may point unerringly to a spy. In short, a product of rubber may prove to be a material witness of unimpeachable reliability.

Identification through impressions left by products made of rubber and similar materials is constantly becoming more effective. FBI police training has stressed the importance of crime-scene searches and the necessity of preserving such impressions as may be found.

The role of rubber in this aspect of law enforcement begins at the manufacturing level. Over the years the rubber products manufacturing industry has cooperated fully with the FBI in the creation of the FBI Laboratory's unique Shoe Print and Tire Tread files. The help of the V. L. Smithers Laboratories, Akron, O., in connection with the FBI Tire Tread File has also been of great value.

As the different manufacturing companies develop new designs for shoe heels or soles, or create different types of tread for automotive tires, samples of the new products are made available to the FBI Laboratory. That sample is fully identified and placed in the proper file for comparison purposes. The Shoe Print File contains photographs of rubber and composition heels, half soles, and whole soles manufactured in this country. The Tire Tread File consists of blueprints, drawings, and photographs of tire-tread designs currently in use. A tire-tread impression of a certain size may indicate the type of car involved. In some instances a tire can be positively identified by its individual characteristic marks as having produced a particular impression. Through the FBI, both files are available to all federal and other law enforcement agencies.

[1] Assistant director, FBI, Department of Justice, Washington 25, D. C.

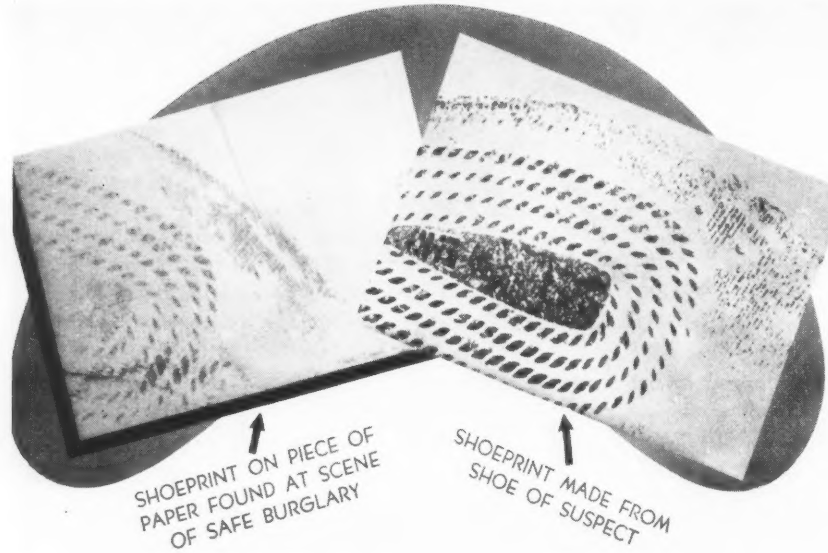

Fig. 2. Shoe print on paper found at scene of safe burglary, *left*, and shoe print made from shoe of suspect, *right*

Heel Imprint Solves Bank Robbery

Not long ago a slender man wearing a shabby overcoat, dark shirt and trousers, and black, low-cut rubbers over his shoes moved with the line of customers to a teller's cage in a Duluth, Minn., bank. The paper he handed the teller was a note reading, "Empty drawers. Put money into the paper bag or I'll kill you."

Within moments the robber walked from the bank with more than $2,500. But he did not make a clean getaway. He lost one of his rubbers, the right one.

Special Agents assigned to investigate the robbery forwarded the rubber to the FBI Laboratory. By means of infrared photography an examiner was able to bring out the almost invisible impressions on its inside sole, showing that the heel of the shoe that had been in it bore the brand-name, "Raw-Cord," a product of a well-known rubber company. (See Figure 1.)

Three weeks later a Montana county sheriff was interviewing a man apprehended by railroad police for pulling a gun, while he was intoxicated, on a fellow passenger. The sheriff noted that the prisoner had almost $1,500 in his possession, money relatively clean and bearing the imprint of the Federal Reserve Bank of Minneapolis. All of the man's clothing was new, and most of it bore the label of a Duluth, Minn., store. The alert sheriff contacted the FBI.

Questioned, the suspect later admitted to an Agent that he had robbed the bank. The discarded pair of old shoes was found. The heels bore the name "Raw-Cord." FBI technicians positively identified the right shoe as having made the impression in the rubber dropped in front of the bank. The robber pleaded guilty and was sentenced to ten years' imprisonment.

Shoe Prints Valuable Clues

It is not easy for a criminal to leave the scene of his crime without leaving behind impressions of his shoes or automobile tires. Photographs and casts of such impressions may be the sole means of placing a criminal at the scene. Like fingerprints, shoe impressions are a most effective item of evidence. The suspect, confronted with obvious similarities between his shoes or automobile tires and impressions found at the scene, often confesses his activities.

I remember the case of a man, arrested for vagrancy, who was suspected of involvement in the murder of a man in his own car. The murderer had taken the car and accidentally wrecked it a little after. Footprints leading from the car showed that he had taken a path across rocky terrain. A search of the rock-strewn land revealed a discarded .38-caliber revolver. It also revealed a single clear footprint nearby. A plaster cast was taken of the footprint. One of the vagrant's shoes matched the print. He was accused of the murder and subsequently confessed.

Another case involved safe burglars who had worn nylon hose over their hands to avoid leaving fingerprints. One of them, however, had stepped on the lid of a cardboard box and left his heel impression. That impression, together with a shoe of one of the suspects, was forwarded to the FBI Laboratory where an examiner effected an identification. The suspect was convicted. (See Figure 2.)

Shoe-print impressions prove particularly valuable in crimes of violence. In one instance heel-print impressions were found in the dust of a yard where a woman had been criminally assaulted. They bore a peculiar design and clearly defined incidental markings. Transients in the neighborhood were questioned, and their heel prints checked. A carnival worker was found to have heels that coincided with the impressions. He was arrested and tried. The prosecutor's case was based primarily on the footprints found at the scene of the

Fig. 3. Example of characteristic alinement of rubber stamp made of individual letters of rubber type

crime. The accused was found guilty.

In still another case the rubber footgear of the victim in a hit-and-run case helped to identify the vehicle involved. The undercarriage of a suspect automobile bore faint impressions of footwear on the greasy steering mechanism. Examination showed that the sole of the victim's shoes had made the impressions. The evidence was sufficient to convict the owner of the auto.

It is not always the rubber heel or shoe which points the finger of guilt at the criminal. I recall a case in which a stolen safe had been abandoned unopened at the outskirts of a city when the thieves had been frightened by the headlights of an approaching car. Officers at the scene recovered a small piece of rubber lying beside the safe. The rubber appeared to have been ripped from a car. Later, four car thieves were apprehended in the stolen vehicle. The car seemed to have a damaged running board. The small piece of rubber, together with the running board, was submitted to the FBI Laboratory. Spectographic analysis disclosed that the metallic content, ash content, and the elasticity and hardness of the two items were identical. This helped convict the four suspects of the safe robbery.

Another product of rubber, adhesive lifting tape, is an invaluable aid to the law enforcement officer. It is essential to the process of "lifting" fingerprints for preservation purposes. A heel print noted on a marble floor or impressed in light dust on a floor of any type can actually be lifted and preserved in its original condition for laboratory examination.

Rubber-Stamp Prints

Rubber stamps also can be helpful, particularly in bringing a certain type of criminal to justice. A rubber stamp in the hands of a fraudulent check writer can be a boon to the law enforcement officer. Like the footprint or tire-tread impression, the mark left by the stamp often bears sufficient unusual characteristics to identify it. These may result from accidental nicks occurring during the use of the stamp or from the operation of cutting out a "one-piece" stamp and mounting it on its sponge rubber cushion.

Defects also may occur in the original type used in making a "one-piece" stamp. Since such defects are duplicated in the mold and in each of the stamps made from the mold, these characteristics can be considered significant only insofar as the identity of the original type is concerned. Characteristics due to foreign matter on the stamp are highly significant. Stamps made up of individual letters of rubber type are usually hand-set, and their alinement characteristics, therefore, are highly significant as identifying factors. (See Figure 3.)

A rubber stamp, even though it contains no letters, may be vitally important. Frederick Joubert Duquesne, leader of the prewar Nazi spy ring involving 33 German agents, in order to authenticate the information submitted by him for transmittal to Germany, identified the material by means of a rubber stamp of a cat with its back bowed and its hair raised. One of the many laboratory identifications which helped in convicting the members of this notorious espionage ring was that of the rubber stamp of the cat used by many of the members as a seal on their letters.

Value of Rubber Product Clues

The impressions of footwear or of tires yield tremendously useful clues to law enforcement. Analysis of shoe prints or tire treads is based on a study of the design, shape, size, wear, cuts and other marks which distinguish a particular shoe or tire from all other shoes or tires, just as the markings of a gun barrel leave their identifying marks on a bullet.

Modern, progressive police training is proving that the clues provided by products of rubber are a vital element in the maintenance of justice.

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New Use for Foamed Materials

Greater use of foamed rubber and plastics in the textile industry is possible by methods patented in 1953 and 1954 by Plaecking and Simon whereby narrow ribbons of the cut foamed material are incorporated in fabrics. Although the invention covers both rubber and plastics foam, the polyurehtane-based foam, Moltoprene, seems preferred, apparently because it can be produced with very low specific gravity and notable elasticity; besides it has good aging properties and resistance to boiling water and various organic solvents.

E. Baschant[1] discusses tests on Moltoprene in various fabrics. By a special process strips of various cross-sections were cut from Moltoprene blocks and used alone, reinforced with a thread of wool, rayon, etc., or as a textile fiber covering.

Fabrics were produced with double-ribbed patterns for the garment industry. Sewing offered no difficulty. Because of the low specific gravity, lighter materials were obtainable for a given thickness than with wool, etc. The open-pored structure of Moltoprene gives a fabric that "breathes"; its heat conductivity is very low, about equal to that of loose, pure wool, and better than that of a wool fabric. A further advantage is that the good insulation values are retained after processing. Another use is for draperies, because of the fabric's sound-absorbing characteristics.

[1] *Kautschuk u. Gummi*, 8, 9, 208 (1955).

EDITORIAL

Disposal of Government Laboratories— Will Industry Display Enlightened Self-Interest?

WITH reluctance the University of Akron, operator on a fee basis of the Government Synthetic Rubber Evaluation Laboratories and Pilot Plant at Akron, O., for the past 13 years, decided on February 15 not to accept the offer of a rent-free one-year lease with an option to buy this facility from the government by June 30, 1957.

An opportunity is therefore provided for one or more rubber companies in the Akron area to show enlightened self-interest and purchase the Laboratories and continue the University as operator.

At this time and in accordance with recommendations made to the National Science Foundation, the government agency now responsible for the Laboratories, the next step is to have Congress provide legislation for negotiated sale. The Special Commission for Rubber Research, in its report of December, 1955, to the NSF, stated that it had found 35 firms interested in either acquiring the Laboratories or utilizing them on a contractual basis. Of these 35 firms, 10 were interested in acquiring the facility on a sale or lease basis.

Also, of the 35 interested firms, the industrial research companies, oil, chemical, and rubber companies ranked in that order in the degree of their interest. Of the 10 companies likely to back up their interest in acquiring the Laboratories with a bid, the oil, chemical, rubber, and industrial research companies ranked about equal.

The Government Laboratories and Pilot Plant cost originally about $2 million and now have a book value of $800,000. It has been said that a volume of business of $1 million a year is necessary for profitable operation.

The University explained its reluctance to give up operation of the Laboratories, as follows:

"1. Even though the work of the laboratory is not classified as fundamental research, there is an opportunity to contribute to the advancement of knowledge, which is one of the functions of a university.

"2. The University would like to remain in a position of rendering service to industry, especially the rubber industry, with which it has long been associated.

"3. The University needs the $50,000 management fee it has received for operating the laboratory. This money has been used in our operations, and if it is lost, we will have to replace it from some other source."

If there was ever a time for the rubber industry companies in the Akron area to display enlightened self-interest, this is it.

Purchase of the Laboratories by one or more rubber companies would not only provide additional facilities for the growing volume of applied research and development that they will require, but operation of the facility as an industrial research institute to do work on a contract basis for other rubber, oil, or chemical companies could be an attractive business proposition in itself. Such an operation could also train more rubber chemists.

It would seem reasonable to expect that if the established rubber industry companies in the Akron area do not acquire this facility, oil, chemical, or industrial research companies will.

R. G. Seaman

EDITOR

Meetings and Reports

Akron Group's "Transportation" Symposium Outstanding Event

"Rubber Meets the Challenge of Modern Transportation," the panel-discussion meeting of the Akron Rubber Group held at the Mayflower Hotel, Akron, O., January 27, again attracted more than 800. Speaker for the dinner-meeting was Otto Graham, of the Cleveland Browns professional football team.

The afternoon panel-discussion program had a slightly different approach from previous programs of this nature of the Group in that the possible future rubber requirements of the automotive industry were first presented by W. J. Simpson, of Chrysler Corp. The challenging specifications for rubber parts of the aircraft of today and tomorrow were then described by E. R. Bartholomew, of the Wright Patterson Air Force Base. A panel of four members then answered these challenges by describing what can and cannot be achieved with present-day polymers and what may be expected with future polymers toward meeting the needs of the aircraft and automotive industries.

The four panel members from the rubber industry were: J. J. Allen, Firestone Tire & Rubber Co., who discussed natural and GR-S type rubbers; B. M. G. Zwicker, B. F. Goodrich Chemical Co., nitrile rubbers; H. C. Evans, Enjay Co., Inc., butyl rubber; and R. Malcolmson, E. I. du Pont de Nemours & Co., Inc., neoprene and "Hypalon." Specialty rubbers such as silicone, polyacrylic, fluorocarbon and urethane types were also discussed by the panel members in their answers to questions presented to them.

The moderator for the discussion was James D. D'Ianni, Goodyear Tire & Rubber Co.

RUBBER WORLD considers the subject, the presentations of the various panel members, the questions and their answers, and the conduct of this symposium by the moderator one of the best efforts of the Akron Group since it has been presenting these panel discussion-type meetings. We recommend to all our readers that they take the time to study in some detail the transcript of this panel discussion which is reported below.

The Dinner Meeting

Kenneth G. Garvick, Mansfield Tire & Rubber Co., chairman of the Group, presided at the dinner meeting, which was preceded by a cocktail party arranged for by the suppliers to the industry.

It was announced that the next meeting of the Group would be in the form of another panel discussion, the subject of which would be "Accelerator Curing Systems." The members of the panel of this meeting, scheduled for April 6, have not as yet been selected.

Nominations for next year's officers of the Group were announced as follows: chairman, Harry M. Brubaker, Witco Chemical Co.; vice chairman, George Hackim, The General Tire & Rubber Co., and Harold W. Catt, The B. F. Goodrich Co.; secretary, Sheldon C. Nicol, Goodyear, and Robert P. Whipple, Firestone; treasurer, Milton H. Leonard, Columbian Carbon Co., and Jack F. Burrell.

Otto Graham, quarterback of the Cleveland Browns, showed moving pictures of some of the games in which his team had participated and talked about football as played in these United States. Graham was recently awarded the annual citation as "Professional Athlete of the Year."

Moderator, left, and the six members of the "Transportation" panel

"RUBBER MEETS THE CHALLENGE OF MODERN TRANSPORTATION" SYMPOSIUM

Introduction

By J. D. D'Ianni

Goodyear Tire & Rubber Co.

This panel discussion has been organized to acquaint you with the problems thrust upon the rubber industry as a result of the ever-increasing demands of modern transportation. The automotive industry, represented by W. J. Simpson, of Chrysler Corp., will state its present and future rubber requirements and specifications in the broadest possible sense. For the aircraft demands of today and tomorrow, a challenge will be thrown at us by E. R. Bartholomew, of the Wright Air Development Center. The gauntlet will be taken up by four rubber experts who will discuss the possibilities and limitations of commercially available elastomers in these tremendously important end-uses.

It is not a new story for us in the rubber industry to grapple with, and vanquish, increasingly difficult problems. In recent years, however, the pace has been so fast that one rubber company tire engineer was quoted in a recent issue of the *Wall Street Journal* as follows: "We have to run like hell to keep standing still." Even so, the average passenger tire life has increased significantly in the past 10 years,

in spite of heavier, more powerful cars, and the availability of super-highways which permit sustained high-speed driving.

In the aircraft field, tires are expected to endure much greater punishment than previously. Loads, landing speed, resistances to extremes in temperature, both high and low, as well as radiation effects, are placing a greater burden of responsibility upon tires and other rubber articles in the new aircraft of the very near future.

The answers to many of the future problems obviously lie in research and development of basic new raw materials by our polymer chemists, although the contribution made by the rubber compounders and designers is an important factor also. We have all seen how the development of GR-S type rubber, along with ancillary improvements in tire fabric, carbon blacks, and other compounding ingredients, has made possible the production of today's superior passenger tire containing up to 75-80% synthetic rubber. The value of this elastomer and other synthetics for special purposes will be described in more detail by our panel speakers.

Can we successfully meet the challenge with which modern transportation is confronting us now, as well as the more demanding requirements which surely lie ahead? Can we make significant improvements, primarily through synthetic approaches, in resistance to solvents and jet fuels, high and low temperatures, ozone, oxygen, sunlight, and other environmental agents of degradation? Can these things be done without sacrifice in other desirable properties, such as resilience, and resistance to abrasion and flex cracking?

The answer today cannot be an unqualified yes. However, the history of the past 20 years suggests that the field of high polymers is still a most fruitful one for experimentation, and we can face the future with guarded optimism. The synthesis of natural rubber has been achieved only in the past year or two. Surely some of our present problems will also yield ultimately to the force of many thoughtful, patient polymer chemists applying their genius to this exciting field of science.

Challenge From the Aircraft Industry

By E. W. Bartholomew
Wright-Patterson Air Force Base

As a representative of the Air Force, I am not sure that it's correct for me to present the challenge *from* the Aircraft Industry for rubber products. In reality, it is the Air Force which presents the challenge *to* the Aircraft Industry to meet specified performance characteristics such as speed, range, altitude, reliability, and pay load. Then, under the present Weapons Systems Concept, the Air Force encourages the industry to seek solutions to the problems which will be encountered in the attempt to meet these performance characteristics.

To assist the Aircraft Industry in general problem areas, however, the Air Research and Development Command has included as one of its functions—basic development of new materials of construction including metals, ceramics, plastics, fluids, polymers, rubber, etc. Since the group I represent is engaged in such development to meet anticipated aircraft requirements, a review of these requirements should constitute the challenge to you in the rubber industry.

While all of you recognize that I am primarily concerned with military applications, I'm sure you also realize that developments for military use are usually quickly transferred into civilian or peacetime applications—for example, the jet transports of the near future.

Basically, the only difference between the demands of the Aircraft Industry and the Automotive Industry for rubber products lies in the extreme difference of environmental conditions to which the parts may be exposed. Both industries require tires, hose, O-rings, weather seals, sealants, adhesives, and other miscellaneous elastomeric components. Unlike with the automobile, however, the rapid failure of even such a simple rubber part as a door or canopy seal on a vehicle flying at high altitude could conceivably result in very serious consequences if a loss of vital pressurization occurred. Such failure, which is not infrequently encountered in an automobile, could readily be caused by ozone deterioration, loss of flexibility at low temperatures, or loss of adhesion to the aircraft structure.

Therefore my first, and relatively simple, challenge to the rubber industry is to overcome these age-old deficiencies of rubber products.

Heat Resistance Essential

Next let us examine the really tough requirements of the Aircraft Industry. In a paper[1] delivered at a recent Rubber Manufacturers Association meeting, my good friend, Major H. C. Hamlin, made a statement to the effect that man has virtually solved all the problems of flight from here to anywhere, at any speed, except the problem of materials from which to make the vehicles. While his statement was intended to include all materials of construction, we will consider only that material in which we are interested—rubber.

As an example, at Mach 3.0 which probably represents a speed of a little better than 2000 mph at 50-60,000 feet, it is expected that the skin temperature of an airplane or missile will reach equilibrium at around 500 to 600° F. (see Figure 1.) Now there is little doubt that the state of the art in propulsion systems will permit us to attain this speed, or far beyond it, but what are we going to use to make this vehicle airtight—in other words, what will we use for door seals, bomb-bay door seals, sealants, etc.? What are we going to use for the fabrication of tires which will probably be stored, during flight, in thin wings, preferably without the benefit of complex and heavy cooling equipment? What fuel-resistant rubbers do we have for fabrication of tanks, seals, hose, and sealants which will withstand these temperatures? And, finally, what about O-ring seals, hose, and other rubber parts for the indispensable hydraulic and lubrication systems which contribute additional heat of their own during operation in high-performance aircraft?

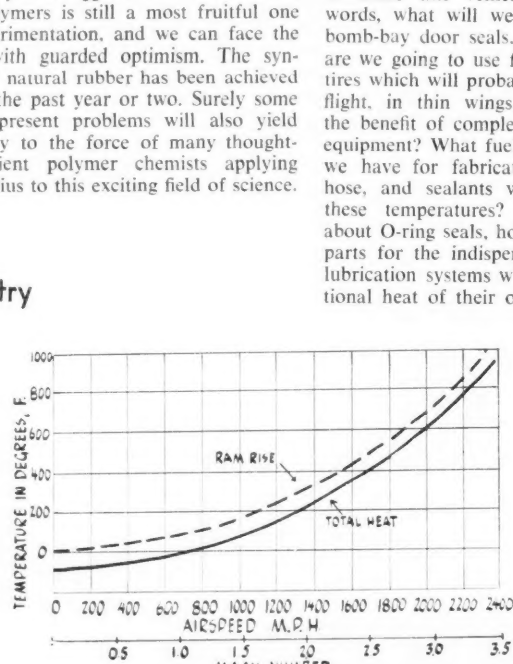


Fig. 1. Temperature rise of exterior surface of plane with increasing speed at air temperature of —67° F.

That this latter problem is very acute becomes apparent when we consider that there may be 500 to 1000 O-ring seals in the hydraulic system of a modern, relatively small fighter aircraft. While present rubber technology can possibly permit us to obtain one or two satisfactory flights under conditions where really high temperatures are encountered, the tremendous maintenance problems involved make operational suitability very questionable.

For this reason I would like to emphasize that we are *not* saying, "give us a 600° F. rubber or nothing." Any substantial gains in the improvements of high-temperature performance of elastomers without too much sacrifice in other properties will be of great benefit.

Likewise, any improvement in the heat resistance of aircraft tires will be of considerable importance. In this case we are most concerned with such properties of a tire as strength, abrasion resistance, tread and ply adhesion, etc., when the tire is already preheated at touch-down. While many factors such as speed, load, number of landing, and age must be considered,

[1] "Rubber—A Vital Factor in the Modern Air Weapon." Major H. C. Hamlin, USAF. RUBBER WORLD, Aug., 1955, p. 601.

tests at Wright Air Development Center have indicated that present aircraft tires may be expected to be marginal in performance at temperatures above 250° F. This may mean that at temperatures above 250° F. the safety factor is reduced, the service life of the tires may be reduced or, in certain cases, the tire may fail on landing. Therefore any improvement in the physical properties of elastomers *while at elevated temperatures* should be of great help toward solving the problems of tires for supersonic aircraft.

Approaches such as insulation and cooling of wheel wells, use of heat reflective coatings and others are under consideration, but it should be pointed out that any solution which requires even one pound additional weight, or additional space, is most undesirable. If we were to stop with the present state of the art in materials development, it is quite conceivable that the day would come when as much horsepower would be required to cool vital components as would be required to propel the vehicle.

This is a situation which we cannot afford to permit, and this also is the situation, gentlemen, which we as a nation cannot afford to lose the race to overcome.

It, therefore, becomes apparent that *heat* will pose the next and greatest challenge to you in the rubber industry. Meeting this challenge, I am sure, will tax the best brains of your research groups, since we already have specific requests for elastomeric materials which will withstand temperatures well above the previously mentioned 600° F.

In view of this, I see no reason to go into great detail on the additional problems resulting from the exposure of rubber components to new and unusual fuels, lubricants, and hydraulic fluids now under development or to radiations from nuclear power plants, or to other special environmental conditions. All of these problems must be met *after* the most serious limitation of rubber-thermal stability has been overcome.

Summary and Conclusions

In conclusion, I would like to point out that in the past the rubber industry has always "come through" with solutions to critical aircraft rubber problems.

The aircraft industry expects you to continue to furnish the necessary solutions to such problems. As has been pointed out, even marginal gains will be welcome, since in many cases they will result in higher performance, improved service life, or elimination of a critical design problem where it has become necessary to remove completely rubber-like materials from a system.

In an effort to solve many of these critical rubber problems, the Air Research and Development Command has engaged the excellent laboratories of many of you represented here to work under contract in an effort to expedite a solution to the problems outlined. Such work is being directed toward the development of new polymers, the development of new compounding ingredients or techniques, and the fabrication of improved end-items. Now I don't mean to imply that all of you should rush to Wright Air Development Center next week for a research contract, but we would certainly be pleased to discuss any new, sound approaches to the solution of rubber problems of air weapons.

Perhaps in this manner, also, we differ from the automotive industry since we recognize that many of the rubber products urgently needed will not involve a sufficient volume demand to establish the required profit motive for the rubber industry. In such instances the Air Force or the Aircraft Industry must accomplish, or sponsor, needed development.

One last personal observation—Someday space travel will become a reality. I leave to your imagination the type of rubber problems which will then pose the challenge to the rubber industry.

Challenge from Automotive Industry

By W. J. Simpson

Chrysler Corp.

It is well known that the growth of the rubber industry has paralleled that of the automotive industry, and that rubber has played a tremendous role in the development of the modern automotive vehicle. Without today's pneumatic tires the automobile could not operate at high or even moderate speed and would not give its present comfortable ride.

Tires, however, are not the only rubber products that enhance the performance of modern cars. For instance, V-belt drives operate many of the important accessories under the hood—fan, water pump, generator, power steering pumps, compressors, etc. We can hardly conceive of operating modern powerful engines without rubber engine mountings. The importance of hose to fuel systems and hydraulic accessories hardly needs to be mentioned. Seals for water, oil, fuel, and air all play their parts to make today's excellently performing vehicles possible. In fact, the modern high-speed, comfortable, excellent performing, and beautifully styled vehicle is greatly dependent upon the many elastomeric products it contains.

It is well known that continous effort is expended in the engineering organizations of all the automotive companies to improve the safety, performance, economy, beauty, and comfort of automobiles. The automotive industry is grateful for the past accomplishments of the rubber industry that have assisted in developing the fine cars of today. Further contributions from the rubber industry, however, will help provide the continuous improvement that the motoring public expects. Numerous new elastomers and improvements in the art of compounding and processing have been announced recently. These accomplishments and more that are on the way indicate that the rubber industry will produce new and improved products for use in automotive vehicles. This talk will propose for discussion by the panel a few questions believed to be of interest to the automotive industry as a whole, which concern rubber applications in automobiles.

Long-Life Tires

A great deal has been said about the "super" abrasion resistance of tire treads made from polyurethane rubbers or other new elastomers. The continued development of new synthetic fibers and the recent announcements of polyisoprene rubbers that duplicate the important properties of natural rubber have also caused considerable discussion.

Knowing of these new developments, can the panel predict whether or not the so-called "100,000-mile tire" can be made? The development of super highways, causing the rapid accumulation of high mileage on many automobiles, will make tires with longer useful life very desirable.

Colored Rubber Products

It is well known that there has been an increased emphasis on color in the use of automobiles in recent years. The motoring public has become very color conscious and is even becoming more or less expert on color harmony. In the light of these trends, color other than black for exposed parts such as window and door weatherstrips, floor mats, pedal pads, grommets, and even tires would seem to be desirable. There undoubtedly will be increased pressure on the rubber industry to develop colored parts such as weatherstrip.

Can colored elastomeric products that have good appearance and that possess good depth of color approaching that of a painted surface be developed to satisfy color-conscious motorists?

Door Weatherstrips

Most automobile doors are sealed with sponge-rubber weatherstrips. The use of sponge rubber for this application has become very popular because it produces soft weatherstrips that take up some door-body clearance variation, and also because it can be readily attached to the door by cementing. If cellular weatherstrip materials could be developed that are consistently softer than those presently used, weatherstrips could be designed in such a manner that more deflection would occur, thus making it easier to seal auto doors.

In the opinion of the panel, can consistently softer cellular rubber with uniform fine cell structure that does not exhibit plasticizer exudation be produced without sacrifice of resilience?

Weather Resistance of Exposed Parts

The severity of the effect of weather on rubber parts installed under conditions of strain seems to be increasing. This situation may or may not be due to high concentrations of ozone in numerous areas. Whatever the reason, the quality of material in rubber weatherstrips has to be carefully controlled to prevent cracking during exposure to weather.

The comments of the panel concerning this problem should be very interesting. If

weather conditions affecting rubber become more severe in specific geographical locations, will rubber materials for exposed body parts continue to perform satisfactorily? The panel members should bear in mind that these parts should not stain body paints, should process readily on conventional equipment (extruders, etc.), should not be too expensive, and should be capable of being assembled easily in mass-production operations.

Synthetic-Rubber Fluid Seals

Seals in today's automobiles do an important job under tough conditions. They operate in a variety of lubricants, hydraulic fluids, and fuels, and at temperatures that once were considered too high for rubber products. Seals withstand a large variety of additives that are used in lubricants and hydraulic fluids (active sulfur compounds, halogenated products, phosphates, fatty acids, methacrylates, etc.).

As engine driven accessories are added to all manufacturers' automobiles and trucks, more difficult seal applications may possibly occur. Do the panel members think that seal materials are becoming available that will last indefinitely at temperatures up to 400° F. and operate satisfactorily in high octane fuels and also in lubricants and hydraulic fluids that will contain a large variety of additives?

Low-Friction Rubber Compounds

The relatively high coefficient of friction of tire treads against pavement surfaces is used to advantage in stopping vehicles. However, the development of as low friction as possible between material used in moving seals and the surfaces against which they operate is advantageous for obvious reasons.

Can the polymer chemists and compounders of your industry produce materials that have as low friction against metal or glass as do some of the solid materials used in seals and bearings?

Latex Dipped Products

The number of boots and similar parts of complicated shape that are fabricated by dipping forms into latex has been increasing. These types of products are useful where complicated shapes are required and also for parts of relatively low production. To some extent latex dipped parts are limited in their performance, because their properties are not always so good as those of molded products and, also, only a limited variety of compounds is available.

Can the properties of latex compounds such as oil resistance be improved, and can the available types of latex compounds be increased? Also, can the use of the latex dipping method for fabricating parts be extended to polymers other than natural rubber and neoprene?

Summary and Conclusions

Other questions that would interest the panel and audience could be given, if more time were available, but the items mentioned should provoke profitable discussion. The automotive and rubber industries have always cooperated well and undoubtedly will continue to work together for ever-improving transportation.

Natural and GR-S Type Elastomers in the Aircraft and Automotive Industries

By J. J. Allen
Firestone Tire & Rubber Co.

W. J. Simpson and E. R. Bartholomew have started this symposium by outlining the future requirements of the automotive and aircraft industries with reference to rubber parts. They have made reference to tires, weatherseals, fluid seals, and other items. They have also referred to more drastic requirements with respect to ozone resistance, high- and low-temperature resistance, and fluid aging under high-temperature conditions with new types of oils and additives.

My assignment is to consider natural and GR-S type rubber and to discuss what can be achieved with these types of elastomers and to point out their limitations for meeting these future requirements.

Tires

Mr. Simpson has made reference to a 100,000-mile tire and has referred to the possible use of polyurethane-type rubbers. It is my understanding that research chemists in the rubber and chemical industries are working on this type of elastomer as well as improved tire fabrics, but the development of such a tire is probably some years away, considering both technical and economic factors.

In the meantime, therefore, we will be dependent upon natural and GR-S type rubbers for our tire requirements for some time. I think it is recognized that the building of more and more superhighways will result in longer sustained speeds, which point in turn brings up the problems of heat resistance and heat dissipation. These problems involve the tire as a whole, including the fabric, design, and construction, in addition to the polymers and compounds.

In general, it can be said that natural rubber and GR-S type elastomers, properly compounded, are meeting satisfactorily today's requirements and probably will do so for some years to come, particularly since we have legal speed limits and a reasonable enforcement of them. Rubber compounders are getting the best properties possible from both natural and GR-S type rubbers, but continued development and research on accelerators, antioxidants, antiozonants, carbon blacks, etc., as well as new and improved types of synthetic elastomers, will, in all probability lead to improved compounds. Any change, however, will be gradual. With respect to the tire problems, cooperation between consumer and manufacturer will be required with respect to design and construction in order to keep within temperature and other physical limitations.

Other Products

With reference to the other products and properties mentioned, natural rubber and the several types of GR-S are filling most of the requirements where high temperatures and oil resistance are not factors. Natural rubber is filling adequately the requirements of engine mountings, functional bumpers, and other parts where high resilience is required. The various types of GR-S, including the oil-extended types, non-staining and low water absorption types, are satisfactory for bumpers, seals, pads, gaskets, and many other parts.

In many instances the choice of natural or GR-S rubber depends upon (1) the particular properties required; (2) the manufacturing operations involved; and (3) the economic factors. It is reasonable to expect that the development of additional or improved types of GR-S could expand the use of GR-S type rubber for many items now made with natural rubber.

As stated in the beginning, the future requirements for rubber involve more severe conditions of heat and cold, weather and ozone resistance, fluid resistance, and requirements for colored parts.

High-Temperature Problems

The high temperatures referred to are in the 300 to 700° F. range. In general, at present, 250° F. is considered as the high limit for a reasonable service life for either natural or GR-S type rubbers.

While natural rubber compounds in general give higher tensile and elongation at elevated temperatures, GR-S compounds tend to age better. They do not show reversion on prolonged heating. It should also be pointed out, however, that tensile strength is not usually an engineering function; therefore other properties must be considered. For most high-temperature applications the other synthetic elastomers must be considered. Other panelists will refer to these.

Low-Temperature Resistance

For automotive applications the low-temperature characteristics have been evaluated almost exclusively by the low-temperature brittleness test, ASTM D736,[2] and, more recently, D746.[2] Other tests such as low-temperature stiffness, hardness, and compression set have been developed and are part of some military specifications. In this connection that test should be selected which gives emphasis to the property that is most important from a service standpoint. With the exception of the silicones, natural and GR-S type rubbers are most suitable for low-temperature uses where oil resistance is not a factor.

In general, GR-S type rubber is considered slightly inferior to natural rubber when evaluated at low temperature by any of the above tests. However, the time of exposure at the low temperature may be a factor. A report[3] from the Mare Island Naval Shipyard on exposure tests in the Arctic indicated that certain GR-S type rubber compounds might not increase in hardness so much as natural rubber compounds on prolonged exposure at –20 and –40° F. although the difference is only possibly five points durometer hardness.

The measure of stiffness at low temperatures as determined by Young's modulus indicates a limit of serviceability of natural

[2]American Society for Testing Materials, 1916 Race St., Philadelphia, Pa.
[3]Rubber World, Mar., 1954, p. 773.

rubber close to -80° F. and for GR-S type rubber of -65° F. In the latter case, the selection of a low-styrene GR-S type rubber and the use of low-temperature plasticizers are required. For many applications including door and weather seals both natural and GR-S type rubbers, particularly the low-styrene types of the latter, properly compounded should be satisfactory for low temperatures of -40 and even -65° F. By properly designing the parts, the shrinkage or stiffening need not cause the part to fail in use.

Ozone Resistance

It is generally accepted that GR-S type rubber compounds are more susceptible to ozone damage than are natural rubber compounds. However, waxes seem to impart more protection to GR-S type rubber compounds for static exposures. In general, therefore, for static applications such as window seals, properly compounded GR-S type rubber has greater weathering resistance than natural rubber. By properly compounding we refer to the use of high quantities of wax plus the use of good antioxidants. It has also been determined that careful and uniform mixing of the compound is required.

On the other hand, the use of wax can be detrimental to ozone resistance in the case of flexing. Recent developments have brought forth a group of chemicals now called antiozonants.[4] They include a number of phenylene diamines, trimethylquinolines, and nickel dibutyl dithiocarbamate. Most of you know their trade names. They are outstanding in the ozone protection which they impart to both natural and GR-S type rubber compounds. However, with the exception of nickel dibutyl dithiocarbamate, the antiozonants impart staining characteristics to the rubber. In many applications this characteristic does not matter, but for window seals, lamp pads, etc., it is detrimental. We are still looking to the chemical industry for good non-staining antiozonants.

Colored Parts

In most instances colored rubber compounds fade or become dull owing to chalking with age and exposure to the weather. This, of course, is undesirable.

A lot of work has been done with colored coatings on natural and GR-S type rubbers. Here the problem is one of permanence of adhesion and permanence of color. All types of coatings including vinyl and "Hypalon"[5] have been tried. Colored lacquers give good initial adhesion, but tend to loosen with age. The most promising possibilities at present are vinyl lacquers or "Hypalon" on either natural or GR-S type rubbers. The other speakers will discuss neoprene and butyl for this application.

Softer Sponge-Rubber Parts

Mr. Simpson refers to softer sponge rubber weatherstrips for doors and deck lids. At present most of these are made with natural rubber, GR-S type rubber, or blends. The sponge is made in three compressions, one psi., 3½ psi., and 7 psi. per 25% deflection. Since the weatherstrips must be water and weather resistant, they are made with thin applied skin of either a 50 or 60 durometer hardness stock of 1,500 psi. tensile strength. This skin is usually made integral with the sponge. The use of sponge rubber permits of greater dimension tolerances on the metal door and trunk lid stampings than would be the case with solid weatherstrips. Mr. Simpson feels that even greater tolerances could be allowed if the sponge were softer and still provide doors with a minimum closing effort and with a weather and watertight seal.

Certainly natural and GR-S type rubbers are suitable for this application as are butyl and neoprene rubbers. The limitation on the softness is controlled by the design of the part, the compression of the sponge, and the hardness or modulus of the skin.

Foamed latex, which can be made in softer compression ranges than chemically blown sponge, is being made into door seals by coating with "Hypalon." This practice may be the answer for the requirements for softer seals. Here again design and economic factors must also be considered.

Summary and Conclusions

In conclusion, therefore, it is safe to say that both natural and GR-S type rubbers will continue to supply the bulk of the rubber requirements for many years. Research work on the part of the natural rubber suppliers will lead to better physical characteristics, higher yields, and more uniformity. The producers of GR-S type rubbers will give us improved properties also and thereby open up new fields of application and overcome some of the present weaknesses of this type rubber.

The resistance of natural and GR-S type rubber compounds to atomic radiation is a property that requires much more study. The possibility of vulcanization by atomic radiation may introduce new or improved properties. Perhaps natural and GR-S type rubber compounds in the future *will* function in applications where they are now limited.

[4] *Ibid.*, Aug., 1954, p. 636.
[5] E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

Oil-Resistant Rubbers Meet the Challenge of Modern Transportation

By B. M. G. Zwicker

B. F. Goodrich Chemical Co.

Simpson and Bartholomew have presented three primary challenges for oil-resistant rubbers: (1) improve resistance to new types of oils and hydraulic fluids; (2) maintain flexibility at lower temperatures; (3) improve resistance to high-temperature aging.

It has been said that hindsight vision is usually 20-20; so let us first look at each of these challenges from the viewpoint of our past experiences. During the early 1940's, two types of nitrile rubbers were available. One had good oil resistance similar to that of the original German Perbunan; the other was developed to meet more high oil-resistant needs for automotive and aeronautical engineering.

At the beginning of World War II most lubricating oils and gasolines were paraffinic petroleum types with only moderate percentages of aromatics. Low-temperature requirements rarely exceeding a brittleness of -40° F. and high-temperature performance in the range of 225 to 250° F. were considered adequate. The nitrile rubbers could be compounded with the relatively few softeners then available to meet these general requirements with relatively little difficulty.

Oil Resistance

As you have already heard, these early use-conditions did not long endure. Many will vividly recall the crisis in fuel cells when our planes tried to use Indonesian aromatic gasoline. The trend has continually been toward higher speeds, more powerful engines, higher operating temperatures, and automatic controls. These trends in turn have led to high octane fuels, high-temperature lubricants, and specialized hydraulic fluids. With these developments, improvements had to be made in the resistance of the rubber compounds. Both rubber compounder and polymer manufacturer have made significant contributions to improvements in all three critical properties.

The polymer manufacturer developed rubbers with higher-percentage acrylonitrile to meet the demand for greater resistance to volume change in low aniline point oils. Polyacrylate rubbers were found to meet the need of a rubber material that would not become brittle after prolonged aging at 300-350° F. in the sulfur-bearing, extreme pressure-type lubricants and hydraulic fluids. In passing, it should be mentioned that butyl rubber has been used for some of the highly polar ester-type fluids, but this subject is Mr. Evans'.

Compounders made critical selections of new compounding ingredients and construction techniques. Owing to the greater number of properties now being specified for various rubber products, this selection continues to be more exacting and usually requires compromises in other properties in order to obtain desired swell and shrinkage properties. Laminates often solved these problems better than single constructions. The automotive and aeronautical engineers also helped by modifying their design and selection of compromise lubricants to minimize demands on performance of the rubber parts.

Low-Temperature Flexibility

Low-temperature flexibility received increased attention in the late 1940's and early 1950's. Operation of military vehicles in Arctic regions, together with higher altitude flying for aircraft, has demanded performance of oil-resistant rubbers at temperatures approaching -100° F. To meet this challenge, two approaches have been used:

(1) New ester-type low-temperature plasticizers were developed for the compounder. While better low-temperature flexibility of rubber compounds is obtained with these materials, it has been at the cost of increased shrinkage of the rubber part due to extraction of plasticizer by the oil. High-temperature resistance is also impaired owing to loss of plasticizer by volatilization.

(2) Lower acrylonitrile polymers were developed at some sacrifice in tensile strength properties. A more serious difficulty, however, is that oil resistance varies directly with acrylonitrile content, while low-temperature flexibility is inversely proportional to the percentage of acrylonitrile in the rubber. This situation again calls for a compromise.

Compounders have often found that the best method of meeting present specifications has been by proper combination of both methods and designing to a performance standard for the specific part. Thinner cross-sections also minimize the stiffening of the polymer at the lower temperatures and thus make more durable parts. The machine design has also been modified to allow for warm-ups prior to operation or to provide for directly heated components.

High-Temperature Resistance

High-temperature resistance is the most recent serious challenge for oil-resistant rubber components. With the commercially available materials the compounder has already made significant contributions. Low sulfur and sulfur-free vulcanization systems impart improved heat resistance to the rubber compound. More recently, peroxide-type cures[6] have been found to impart both improved heat resistance and better low-temperature flexibility than do the more conventional curing systems. The use of up to five parts of low volatility antioxidants in the compound also supplies a slight further improvement in resistance to heat deterioration, although the last word in high-temperature plasticizers has yet to be written. Some of the polymeric plasticizers are helpful where low-temperature flexibility is not a critical problem.

With the advent of polyacrylate-type rubbers, the effective operating temperature was raised approximately 100° F. above that of the best nitrile rubber compound then available. Oil resistance is equivalent to that of a medium acrylonitrile rubber, and resistance to sulfur and chlorinated compounds is excellent.

Unfortunately, as Mr. Simpson mentioned, low-temperature properties of the polyacrylates do not approach those of nitrile rubbers, although with proper design they have performed adequately under average driving conditions in the U.S.A.

In summary, we see that the polymer manufacturer, the rubber compounder, and the design engineer have, through compromise, been able to provide consumers with reasonably serviceable products during the past 15 years. With some exceptions, we believe we can provide parts that are serviceable from —50° F. with nitrile and polyacrylic rubbers for hydrocarbon oil-resistant applications.

6 "Peroxide Cures of Nitrile Rubber." C. H. Lufter, RUBBER WORLD, Jan., 1956, p. 511.

Possible Future Developments

Now for the cloudy crystal ball . . .

Both Mr. Simpson and Mr. Bartholomew have confirmed our opinion that the trend toward expansion of the effective operating range at both ends of the temperature scale and exposure to new types of fluids for both automobiles and aircraft will continue at an accelerating rate. It would help us to know what these new fluids are likely to be, well in advance of their commitment to design. Closer cooperation between the design engineer, the rubber compounder, and the polymer manufacturer might keep us better balanced in our work.

Future improvements through compounding are likely to be less productive than those of the past—at least with existing polymers. One obvious need is of a good, low-temperature plasticizer which would not volatilize when exposed to elevated temperatures. Greater improvements will probably come through modification of present polymers or by development of entirely new polymers.

Restricting my comments to nitrile and polyacrylic rubbers, the recently announced carboxylic rubber is a step in this direction. With this product, a high degree of oil resistance is maintained, while the brittleness temperature is extended to minus 90° F. It should be noted, however, that although brittleness has been markedly improved, low-temperature flexibility is only equivalent to that of a normal nitrile rubber of comparable oil resistance.

Two other requests were made by Mr. Simpson—(1) a lower friction oil-seal rubber; (2) more oil-resistant latex dipped goods.

There are compounds based on graphite, cork, and cotton flock that have been recommended for nitrile rubbers to reduce friction. Further reduction of friction can be achieved by increasing modulus and hardness. The new carboxylic rubbers should be seriously considered because of their unusual hardness-elongation relation.

In the field of nitrile rubber latices, substantial progress is being made toward a good material for dipped goods. In fact, the new carboxylic latices look especially promising with recent compounding techniques, and latex dipped-goods manufacturers should soon be able to offer parts with excellent oil resistance.

Polymers from higher acrylates have long been studied for improved low-temperature flexibility, but with retention of the excellent high-temperature properties typical of commercial polyacrylate rubber. Progress in this direction may seem disappointing to consumers, but we want to make a substantial improvement rather than to offer a series of marginally better products. While it is true that there is no progress without change—change in the specialty rubber parts business is also expensive.

Thus, we must conclude that there is no revolution in sight that will solve these problems overnight. Extensive, specialized compounding studies may develop an excellent rubber product for a specific application. Experience dictates, however, that we must always end in a compromise.

For example, which do we need most: good heat resistance or aromatic or diester oil resistance? Which is more critical: low-temperature flexibility or high-temperature resistance?

While Mr. Bartholomew gave us a reluctant answer for aeronautical requirements, the decision for automotive is more difficult.

So much for the hedging. It is our continued research objective to develop and improve oil-resistant rubbers by expanding their applicability over a wider temperature range while maintaining or improving oil resistance. In the foreseeable future we expect to achieve materials with adequate performance over a temperature range of —100° F. to +400° F. by better compounding and with improved nitrile and polyacrylate rubbers. We cannot visualize operations at 500° F. and above with these types of polymers.

Our prediction on temperature range is not for ASTM laboratory tests, but rather for field performance. For example, polyacrylate fails at —10° F. on the laboratory brittleness tests. In actual service, however, certain types of seals have given satisfactory performance at start-up and continuous operation in oil at —40° F.

Therefore, to meet these challenges most effectively, we believe the burden should be shared equally by machine designers, rubber parts manufacturers, and polymer manufacturers. Success or failure of a part is often a matter of a few degrees of temperature or a few percentage points higher aromatic content in the oil. If the machine designer and the compounder work closely to engineer satisfactory performance with existing rubbers for today's needs and write tomorrow's needs well in advance, the polymer manufacturer may be able to have the superior rubber available for tomorrow's advanced design. It takes time and money to develop a new specialty rubber, but it takes much more time and money to get it written into the specifications. The larger the jumps, the less the wasted effort, and the more value the ultimate consumer will receive for his money.

Neoprene and "Hypalon" Synthetic Rubber Meet the Challenge

By R. W. Malcolmson

E. I. du Pont de Nemours & Co., Inc.

I would like to tell you now something about our ideas on how neoprene and "Hypalon" might meet the interesting challenges put forth by Mr. Simpson and Mr. Bartholomew. Of course, you have probably noticed the understandable reluctance of the panel to show much hope of meeting Mr. Bartholomew's particularly severe requirements, at least not with today's familiar polymers. Nor can I suggest that neoprene and "Hypalon" are panaceas for *all* of Bill Simpson's different, though generally less severe, problems. Nevertheless it

is certain that both neoprene and "Hypalon" will play an important part in the solution of *many* of these problems.

Neoprene, of course, is an old friend to most of you. Relatively speaking, neoprene is a mature material. Major improvements in the basic polymer in the next several years are probably less likely than they were during the earlier days of neoprene. However, we can expect that improved neoprene polymers will be developed in the future, as in the past, to help solve some of the problems which have been described to us.

Ozone Resistance

Bill Simpson mentioned the need of improvements in the ozone resistance to automotive rubber products. At the same time the automotive industry must be very realistic about the prices which it pays for the thousands of components which go into a car. The two requirements of excellent ozone resistance and low cost can be met in many cases by the use of oil-extended neoprene compounds based on Neoprene Type WHV. In many SAE[7] grade numbers, such stocks are competitive in cost with compounds made of lower priced general-purpose synthetic rubbers. As a result, there is a definite trend in the automotive industry toward the adoption of more Type WHV stocks, particularly under the hood, to replace less satisfactory compounds based on other types of synthetic rubber. This idea of oil-extended neoprene compound, then, represents one very practical approach to the ozone resistance requirements of the automotive industry.

"Hypalon"

In talking about "Hypalon"[8] a little more background is warranted. For "Hypalon" is much newer material and is probably less familiar to most of you than neoprene. Chemically, "Hypalon" is chlorosulfonated polyethylene. In terms of the problems which have been presented here today, the properties of "Hypalon" which are of the greatest interest are these: First, excellent resistance to ozone and weathering. In fact "Hypalon" is for practical purposes ozone-proof. Second, ability to be produced in any color and with excellent color stability. Third, excellent resistance to dry heat. Fourth, nominal oil and solvent resistance.

With this highly desirable combination of properties "Hypalon" provides answers to a number of automotive industry problems. For example, color-stable, weather-resistant rubber parts for such applications as weatherstrip or sponge door strip. In fact, in the latter case "Hypalon" coatings (in a black color) are already used by one of the major automotive companies to provide ozone and weather resistance. It is only a step from this point to colored coatings for the same application.

Bill Simpson mentioned very briefly the need of improved convertible top materials. One company has already adopted "Hypalon" coated fabric for this use. Others are actively evaluating "Hypalon" in convertible tops. The advantages: "Hypalon" is less temperature-sensitive than the currently used coatings, and, based on all experience to date, "Hypalon" coated fabrics clean easier than present constructions.

At the present time "Hypalon" is produced in relatively small volume. Consequently the cost is high compared with that of other elastomers. You may, however, have read recently about the new "Hypalon" plant which is now under construction in Beaumont, Tex. With volume production and growing consumption, the trend in price will certainly be downward. This will accelerate the acceptance of "Hypalon" for many automotive products where cost now rules it out.

For the immediate future, however, "Hypalon" will still be a premium-priced elastomer. Therefore we are doing a considerable amount of work on blends of "Hypalon" with other less expensive materials. Formulations have already been developed which have the weather resistance and color stability required for automotive purposes at substantially lower cost than could be obtained in all-"Hypalon" stocks.

Not only is "Hypalon" handled by normal rubber industry fabricating methods such as molding, extrusion, calendering, etc., but it is also very well adapted to use in solution-type coatings. This, too, represents an economical way to obtain both color and protection on automotive products.

We feel that "Hypalon" coatings have some very definite advantages. The use of carbon black in the average rubber shop makes color control a difficult problem, particularly control as close as that demanded by the automotive industry. However, the use of a flexible coating on a neutral or black-colored molded or extruded part is probably practical in many cases. This practice would certainly simplify color control substantially and, perhaps of equal importance, simplify the scheduling problem by having a single molding or extruding compound and several color coatings which could be applied later to make the finished product.

Heat Resistance

Mr. Bartholomew mentioned the importance of marginal improvements as stepping stones to the final goal. I'd like to illustrate this with an example from automotive industry experience. For years neoprene has been the standard material for spark-plug cover compounds. It has the resistance to heat, ozone, and oil which is required. In the past few years, however, new engine designs have tended to place exhaust manifolds closer and closer to the spark plugs, making the heat resistance requirements extremely rigorous. In some cases neoprene is no longer adequate. Solutions to the problem have varied. One manufacturer changed from neoprene to silicone rubber, a solution which cost him nearly 50¢ per car; another attached metal heat shields between the manifold and the plugs to reflect the radiant heat so that neoprene could continue to be used. But this solution, too, meant additional cost.

"Hypalon" has all of the required properties for the job; in fact its top service temperature limit is about 35-40° F. above that of neoprene. So one manufacturer took advantage of this in his new V-8 engine. "Hypalon" spark-plug covers were used *without* heat shields to give the most economical solution to the problem. Another major producer is now on the verge of making the same change which will allow him to eliminate metal heat shields at an attractive saving.

Urethane Foam

I'd like to leave neoprene and "Hypalon" now for a moment. One subject we haven't touched is the need of padding materials to satisfy the demands of the automotive industry for safety features in its cars. In this field, the urethane foams[9] seem ideally suited. Their foam-in-place characteristic makes it possible to produce parts of complex contour, for example, the padded instrument panels now in use. In addition, the range of properties which can be built into urethane foams by chemical means is almost limitless. Requirements have not yet been firmed up by the automotive industry on the deceleration and energy absorbing properties of safety padding. I am reasonably certain that urethane foam formulations can be developed to meet whatever requirements are ultimately agreed upon. Some very interesting and promising possibilities along this line have already been developed and are being evaluated.

Summary and Conclusions

By way of recapitulation, oil-extended neoprene compounds provide an economical solution to the need of improved ozone resistance where color is not required. "Hypalon" compounds have the ozone and weather resistance and the color stability needed for future requirements. The use of blends of "Hypalon" with other elastomers or the use of "Hypalon" coatings will help minimize the price premium for such colored parts. In the safety padding field, urethane foams will certainly be a tremendous tool for the automotive industry to use in solving its problems in the future.

Butyl and the Automobile and Aircraft Industries

By H. G. Evans
Enjay Co., Inc.

The Aircraft Industry through Mr. Bartholomew stresses its interest in higher heat resistance, usually in combination with lubricant and fuel resistance. Temperatures above 400° F. are too destructive to butyl rubber for continuous service; however, where a marginal improvement is desirable, butyl rubber should be examined, as it is superior to many of the other well-known rubber polymers.

When aircraft parts are required to withstand hydrocarbon lubricants and

[7]Society of Automotive Engineers, New York, N. Y.
[8]See RUBBER WORLD, Mar., 1953, p. 791; Apr. 1953, p. 54; June, 1953, p. 348.
[9]*Ibid.*, Mar., 1955, p. 765.

fuels, butyl rubber cannot be recommended, but butyl rubber is highly resistant to oxygenated hydrocarbons. For example, butyl rubber is recommended for its resistance to the phosphate esters commonly used in aircraft hydraulic fluids. As similar oxygenated compounds for lubricants and fuels are developed, butyl rubber should certainly be considered.

Oxidizing agents for propellants require corrosion-resistant rubber parts. Butyl rubber is well known for its acid resistance, and butyl or its homolog, Vistanex,[10] should be investigated for this service.

Aircraft rubber parts are subject to ozone attack. Where this problem is not combined with mineral oil resistance, we recommend butyl rubber.

We are more receptive to the challenges of Mr. Simpson and the Automobile Industry. By choosing our ground we can become aggressive. Without reservations we recommend butyl rubber as the answer to the following challenges: (1) tires with longer service life; (2) weather-resistant rubber parts; (3) colored rubber parts; (4) soft sponge weatherstripping; (5) safety padding.

While discussing the properties of butyl rubber that answer Mr. Simpson's challenges, we would like to list some other properties of this rubber that might well be utilized to improve the rubber parts on today's automobiles.

What are these qualities of butyl rubber that make it so adaptable?

Weather Resistance

Butyl rubber has excellent weather resistance. For example: (1) A colored butyl rubber molded part has retained more than 80% of its tensile strength and elongation after 14½ years of test rack exposure. (2) After nearly eight years of exposure to weather in Utah, the compound on a butyl-coated fabric shows by test essentially no deterioration.

Numerous other cases can be cited to show that not only black but weather-resistant, vivid colored parts, to match the styling, can be made from butyl rubber. Weather aged samples show no sign of "alligatoring," chalking, or fading.

When the term weather resistance is used in its broadest sense, that is, resistance to outdoor exposure, the following general recommendations can be made: (1) Use Enjay Butyl grade having minimum unsaturation consistent with limitations of product or process. (2) Increase zinc oxide content of compound to about 20%. (3) Use optimum cure for the butyl rubber compounds. (4) Use minimum loading consistent with economics and process requirements. [(a) Furnace and thermal carbon blacks are generally better than channel blacks. (b) Mineral fillers are generally better than carbon blacks.] (5) Have good dispersion, which is necessary. (6) Use minimum plasticizer content—high-viscosity mineral-oil plasticizers are preferred. (7) Note that coloring pigments vary in their ozone resistance effectiveness in butyl compounds. (8) Realize that quinoid cure is normally better than sulfur cures (more staining with sulfur). (9) Note that wax up to 10 PHR can be used without excessive bloom. (10) Achieve freedom from contamination with other vulcanizable polymers (except brominated butyl rubber).

Temperature Resistance

Butyl rubber is resistant to high temperatures and has already been selected for a number of services where this property can be used. Products such as Bag-O-Matic[11] tire curing press bladders, steam hose and hot materials belts made with butyl rubber are not directly a concern of the transportation industry, but they do indicate the degree of heat resistance inherent in butyl rubber compounds.

One of the interesting characteristics of butyl rubber is its freedom from hardening during high-temperature aging. In reinforced rubber parts the fabric or yarn is protected by having a rubber that remains soft and flexible throughout its life.

Compounding recommendations for this type of application are: (1) Use butyl rubber of highest unsaturation. (2) Use quinoid-type cures for superior products. (3) Use low sulfur-high acceleration ratios. (4) Note that certain accelerators such as tellurium diethyl dithiocarbamate or selenium diethyl dithiocarbamate are superior to others. (5) Realize that high state of cure for the compound is essential.

Abrasion Resistance

Butyl rubber has good abrasion resistance, if not better, at least as good as that of other general-purpose polymers. This property is best used in tires, black or colored. Unfortunately, standard wear tests are conducted over short time intervals where the effect of aging on wear cannot be evaluated. Average motorists who drive 5-10,000 miles a year, and who must usually replace tires at less than 30,000 miles, should be able to show greatly increased mileage when using butyl rubber tires. Other advantages of butyl rubber treads are freedom from noise during cornering, low noise level of mud and snow designs, and freedom from chipping and cut growth.

Recent tread compound development work[12] indicates that minimum abrasive wear is obtained by designing the compound to be dynamically soft, while at the same time maintaining high rupture resistance. In other words, a soft, tough compound is desired.

Heat treatment will improve this property in present commercial grades of Enjay Butyl, although our tread development is directed toward the use of polymers of high molecular weight.

Low concentrations of sulfur and accelerator serve to maintain dynamic softness, and channel blacks together with high-viscosity mineral-oil plasticizers, are recommended.

Dynamic Properties

Butyl rubber has unusual dampening properties; in fact, here is a characteristic that has wide applications. It might be said that butyl rubber contains its own built-in shock absorber. In a search for a new means of improving riding comfort of the modern automobile, this property is being used in the design of suspension systems.

The dampening qualities of butyl rubber can be varied within limits by adjustment of: (1) amount and type of reinforcing agents used; (2) unsaturation of butyl rubber used and cure state of compound; (3) plasticizer type and amount; (4) mode of cure; (5) mixing procedure, such as heat treatment.

When the important feature of riding comfort is discussed, again the use of butyl rubber in tires cannot be overlooked. Those who have ridden in cars equipped with butyl rubber tires will attest to the freedom from vibration or noise while driving over rough roads or cobblestone pavement.

This vibration absorbing quality of butyl rubber is also observed in chemically blown sponge. Where dynamic softness is desirable, such as in safety padding and door weatherstripping, butyl sponge should be the answer. Good age resistance, low compression set, and high tear resistance in colored parts have focused considerable attention on butyl rubber for sponge applications.

Resilient compounds can be produced where needed, but usually to the detriment of some other qualities. A dead, logy feel has always been indicative of low-grade or undercured compounds, or poor compression set properties, but is decidedly not true with butyl rubber.

General Observations

Other outstanding properties of butyl rubber that find limited applications in the automotive and aircraft industries are its electrical properties, moisture resistance, and chemical resistance.

Bromine modified butyl (Hycar 2202)[13] has essentially all of the desirable properties of regular butyl rubber with certain important additional advantages. Brominated butyl is faster curing and can be blended with GR-S and natural rubber, thereby imparting the desirable properties of butyl to these polymers.

Compared on the basis of performance, butyl rubber will give more years of satisfactory service for the same cost than other general-purpose polymers.

In discussing rubber and compounding costs we would like to inject a word of caution. This discussion has summarized the properties of butyl rubber as they enhance the performance of rubber parts. It is therefore by performance alone that the qualities of the butyl rubber parts should be measured. Care should be taken in using SAE-ASTM specifications for purchasing rubber parts made from butyl rubber. We refer specifically to the specification number defining tensile strength and hardness. In butyl rubber compounds the only property that is measured by a tensile test that cannot be measured better by other means is tensile strength. Where arbitrary high tensile requirements are demanded of rubber compounds made from butyl, the

[10] Enjay Co., Inc., New York, N. Y.

[11] McNeil Machine & Engineering Co., Akron, O.

[12] RUBBER WORLD, Oct., 1955, p. 59.

[13] B. F. Goodrich Chemical Co., Cleveland, O.

rubber compounder is severely restricted in the design of the part, and the purchaser will usually find that the purchase price is no longer competitive.

May we suggest that the butyl compound be designed for the service first and defined by specification later.

Questions and Answers

Q. Will LTP GR-S type rubber replace hot GR-S completely during the next five years?

A. Allen. Probably not. There are many uses where compounds for adhesion, low water absorption, etc. require hot GR-S type rubber. In fact, hot GR-S is adequate in most uses where wear is not a factor. Possibly LTP GR-S type polymers with properties similar to hot GR-S types will be produced in the future, but the need has not been stressed up to the present.

Q. Should the rubber industry have a substitute for styrene, in times of benzene shortage? Should they support such a substitute with purchases, even in a time of relative plenty? Example—vinyltoluene.

A. Allen. A large number of substitutes for styrene have been tested. Many have proved satisfactory, among which are vinyltoluene, methyl styrene, and methyl methacrylate. This problem is one of economics. It may be more expensive to set up to manufacture a substitute than to expand the facilities for benzol production. We do not believe that the production of these alternate monomers should be supported with purchases.

A. Evans. It is possible that benzene might get into a position of short supply and so restrict the amount of styrene produced, but this problem does not appear to be immediate. Although benzene is an important raw material for many growing uses besides styrene, it must be remembered that we are no longer dependent upon coke ovens and tar distillers as the sole source of supply.

There is, today, a sizable installed capacity for producing chemical-grade benzene from petroleum amounting to about one-third the total annual capacity of about 360 million gallons. Market requirements are not at this level as yet despite the heavy demand for styrene occasioned by the present high GR-S type rubber output. In fact, it will probably be 1959 or 1960 before demand catches up to total capacity, and, doubtless, before that comes to pass further expansion of petroleum benzene will have occurred.

In other words, we already have an alternate source of styrene raw material in petroleum benzene.

Q. What improvements can be expected in general-purpose oil-resistant polymers during the next few years in regard to heat resistance and solvent resistance?

A. Zwicker. I have already mentioned our prediction on heat resistance—up another 50° F. from present materials. However, solvent resistance is more difficult to answer in generalities. The recent article by Major Hamlin[1] of the U. S. Air Force presents an excellent review of the problem, and we agree that a fundamental change in polymer composition will be needed to meet the mutual requirements of new liquids at higher temperatures.

Engineering in aircraft design to get around low-temperature flexibility requirements for rubber parts and cooperative work by polymer manufacturers and engineers to determine the proper solvent or oil to be used in aircraft in contact with certain polymers could result in substantial improvement in performance of rubber parts.

Q. What temperatures and what oils, fuels, etc., can be expected as necessary to be resisted in the near future?

A. Simpson. It is difficult to predict the type of fluids that may develop because they change so fast, and there are so many manufacturers of lubricants and fuels. However, the variety of additives seems to be growing and probably will continue to include the general types given in the opening remarks. There is also a tendency for a larger range of aniline points of lubricants which effect rubber swelling characteristics. The aromatic content of fuels seems to be rising as higher octane ratings are produced, and this situation will require "rubbers" with greater solvent resistance. Cooperative efforts between the rubber industry and producers of fuels and lubricants, each considering the other's problems, would seem to be a very desirable means of achieving continued good sealing of all hydraulic units as changes occur.

As stated earlier, 400° F. seems to be a maximum temperature to consider in the next few years. It should be pointed out, however, that seal materials should withstand fuels and lubricants at these temperatures in the presence of some air.

A. Bartholomew. Anticipated temperatures to be encountered by elastomers in contact with various aircraft fluids are as follows:

Fluid	Temperatures to Be Encountered by Elastomers in Contact with Fluids
Engine lubricants: (diesters currently in use)	300° F. for continuous operation peaks of 400° F.
Diesters (experimental)	300-400° F. for continuous operation peaks of 450° F.
Pentaerythritol esters (experimental)	350-400° F. for continuous operation peaks of 450° F.
High aniline point mineral oils (experimental)	350° F. for continuous operation peaks of 450° F.
Silicone oils, alkyl silanes, polynuclear aromatics (all experimental)	500° F. for continuous operation peaks of 600-650° F. (have many deficiencies as lubricants which must be overcome)
Hydraulic fluids: petroleum base (e.g., red oil, currently in use)	275° F. for continuous operation
Hydraulic fluids (*cont'd*): high aniline point mineral oils (experimental)	400° F. for continuous operation peaks of possibly 700° F.
Silicone oils, alkyl silanes, polynuclear aromatics	500° F. for continuous operation peaks of 700° F.
Fuels: aromatics (reciprocating engine fuels, e.g., 70/30 isooctane/toluene, the standard test fuel)	400° F. for continuous operation peaks of 550° F.
JP-4, JP-5 jet fuels	400° F. for continuous operation peaks of 550° F.

Q. Discuss nitrile rubber in synthetic oil requirements as developed for new government specifications.

A. Bartholomew. Compounding studies with nitrile rubber at WADC have shown that 275 to 300° F. is the upper temperature limit for application in diester lubricants.

All the compounds prepared from existing nitrile polymers cracked (in laboratory tests) after as little as 24 hours at 290° F. in MIL-L-7808[14] engine oil.

A new synthetic lubricant-resistant elastomer specification is soon to be released by WADC, one class of which will be devoted to nitrile rubbers.

The tentative details of the class are:

Temperature range: −65 to +275° F.
Test specimen: O-ring—AN6227-19
Physical properties after aging 70 hrs. at 275° F. in Plexel 201[15] +½% phenothiazine (a commercial diester with antioxidant used as a standard test fluid).

Tensile strength:	900-1000 psi.
Elongation (without cracking):	130-150%
Hardness (Shore A):	60-80
Volume changes:	+1 to +10%
Compression set:	70 hrs., 250° F. (in air) 35% max.
Temperature retraction (TR-70):	−25° F.

A. Zwicker I assume that this question refers to the new MIL-L[14] 6085, 6387, and 7808 synthetic oils for use at 300-350° F. Because of their chemical nature, the polyacrylic rubbers withstand these materials better at high temperatures than the nitrile rubber, although volume swell and tensile loss is substantial with both types. At lower temperatures and for short periods of time, nitrile rubbers are somewhat superior to the polyacrylics in resistance to these ester-type oils. However, generalizations are difficult.

A given oil such as MIL-L-6387 in contact with a high acrylonitrile content rubber compound at 300 or 350° F. swells it about as much as ASTM #3 aromatic oil. However, tensile and elongation loss is substantially greater with the synthetic oil. The MIL-L-6085 oil is less severe on both swell and tensile loss, but elongation loss is substantial, even at 250° F. This situation may be due in part to selection of additives for the oil which attack the unsaturated rubber. Cooperative work with the oil compounder might improve this situation substantially.

[14]Specifications Branch, Wright Air Development Center, Wright-Patterson Air Force Base, Dayton, O.
[15]Rohm & Haas, Philadelphia, Pa.

Conversely, Turbo Oil 15[16] swells high acrylonitrile rubber compounds about the same as ASTM #3 at 350° F. and reduces elongation in about the same manner, but tensile loss is much more rapid with the synthetic. A different type of reaction is implied, but it may also be related to chemical additives in the oils rather than the nature of the oil itself.

Q. What is the current end-use pattern for butyl rubber? What will be the major use of butyl in transportation items?

A. Evans. The current end-use pattern for domestic sales of butyl rubber for 1955 is estimated as follows:

	%
Transport (tubes, valves, tire curing bags and bladders and exper. tires)	86.5
Non-transport	13.5
	100.0

A further breakdown of the non-transport items would be approximately as follows:

	%
Mechanical goods, including hose, belts, etc.	6.33
Wire and cable	3.4
Cements and adhesives	1.53
Coated fabrics	1.1
Can seals	0.4
Sport goods, bladders for footballs, basketballs, etc.	0.5
Miscellaneous	0.24
	13.50

The major use of Enjay Butyl in transportation items will shift from inner tubes to tires during the present transition period.

Q. How does butyl rubber compare with other rubbers used in tires for price? For physical properties? For processing behavior?

A. Evans. The price of Enjay Butyl is equivalent or lower than the price of the GR-S type rubbers. Some physical properties of Enjay Butyl are quite different from those of GR-S. Tensile and modulus characteristics in tire-type compounds will be of the same order of magnitude. Tear resistance is superior to that of the GR-S types, and weather resistance of Enjay Butyl compounds is also better than with GR-S. Rebound properties of Enjay Butyl compounds are not so good at room temperature as those of GR-S compounds, but at temperatures above 70 or 80° C. the rebound properties of the butyl compounds are equal to or better than those of similar GR-S compounds. Compounds produced from Enjay Butyl are easy to process and are equal to other rubbers being used in tire manufacture.

It is assumed that the preceding question, directed to determining if there are possibilities for producing a lower hysteresis polymer for truck tires, is concerned with GR-S type rubbers. As we indicated before, the room temperature hysteresis properties of Enjay Butyl are not particularly good. At elevated temperatures, however, such as those that might be encountered in truck tire operation, the hysteresis properties of butyl compounds are equivalent to or better than those of either natural or GR-S type rubbers.

Q. What polymer meets the following requirements: (a) low permeability; (b) compatibility with natural and GR-S type rubbers; (c) absence of deteriorating effects on fabrics?

A. Evans. Brominated butyl has low permeability to air, actually equivalent to the excellent resistance of regular butyl rubber. Brominated butyl is compatible with both natural and GR-S type rubbers; however, the long-term effect of brominated butyl on fabrics has not been determined.

A. Malcolmson. I think that the industry's general experience is that properly compounded neoprene will meet these requirements. Certainly it is acknowledged that neoprene has low permeability to most gases. In addition, blends of neoprene with natural or GR-S type rubbers are quite common. For example, white sidewalls made from blends of natural rubber and neoprene have been produced in large volume for quite a number of years. By the same token, there have probably been hundreds of millions of pounds of neoprene used in fabric coating applications. Deterioration, generally speaking, is experienced only under extremely severe service conditions, notably high temperatures, and when the neoprene compound is not properly designed. The use of larger than normal amounts of antioxidants and zinc oxide is certainly a compounding principle which should be employed to minimize chances of attack on fabrics.

A. Zwicker. Nitrile rubber approaches the requirements specified since it is compatible with GR-S type rubbers, and to a limited extent with natural rubber, and has no deteriorating effect on fabrics. The resistance of nitrile rubber to gas diffusion is good. A high acrylonitrile content polymer, for example, was reported in the June, 1950, issue of the *Journal of Polymer Science* to have a permeability to hydrogen, nitrogen, and oxygen at 50° C. equal to that of butyl rubber.

Q. What are the prospects of developing rubbers that will not require textile reinforcements?

A. D'Ianni. There seems to be very little prospect of developing a polymer that will not require textile reinforcement in a tire. Tire fabric is an extremely important integral part of the tire and is required to produce stability in tire operations.

Q. What is the status of polyurethane rubber tires? Will urethane rubber treaded tires be available in 1960 for autos? For trucks? What urethane rubber will be most suitable in treads? Is adipic acid-glycol ester-toluene diisocyanate urethane rubber the best compromise between cost and performance?

A. Malcolmson. Tire manufacturers are continuing tests of tires made with urethane rubber treads. In addition, manufacturers of urethane rubbers are certainly carrying on programs to improve the polymers which they have already released or described. It is quite probable that by 1960 tires with urethane rubber treads will be available for passenger cars.

It is probably too early to tell whether experience with these new polymers will be far enough along for them to be used in truck treads by that time. In any case, it is probable that these tires will be in a premium price class and will be limited to the top-quality constructions, at least initially. At this early date I am not sure that anyone has decided which of the many possible polyurethanes is going to be the best.

A. D'Ianni. Passenger tires containing polyurethane rubber treads have been extensively tested in the past year. Adhesion of the experimental tread to the carcass is still a problem, but not so serious as it was earlier. Tread wear ratings have continued to be substantially higher than with a GR-S or natural rubber tread. There is good reason to expect an improvement of 100% or more over conventional treads.

It is anticipated that modifications in the raw polymer and in compounding techniques will make it possible to process a polyurethane tread stock through regular factory equipment and allow tires to be built in the conventional manner.

It is likely that by 1960 there will be limited production of tires containing a polyurethane tread for both autos and trucks. It cannot be definitely stated which urethane rubber will be the most useful for treads since experimental work on a number of different types is still in progress. In the long run the polymer that has the best balance among processing properties, performance, and cost will be the most suitable. The polymer prepared from adipic acid, glycol ester, and tolyl diisocyanate seems to offer, at the present time, a good compromise between cost and performance. It should be pointed out, however, that there are other diisocyanates which, though somewhat more expensive, give better physical properties; so they may end up as equivalent to the system mentioned. Variations in the polyester portion of the polymer are also being studied, but, again, it is too early to make any definite statement as to which would offer the best compromise between cost and performance.

Q. What is the future for isocyanate rubbers in the aircraft and auto industries?

A. Simpson. The isocyanate foam rubber products are finding use in automotive products fairly rapidly. Their use in parts requiring good energy absorption characteristics should increase rapidly if the price comes down with increased volume. Too little experience with solid polyurethane rubbers has been obtained yet to predict accurately their possible application. However, their properties (high strength, good abrasion resistance, etc.) are very interesting, and they should be of value eventually when the rubber industry learns to process them, and their cost comes down.

A. Bartholomew. Very good for specific applications. The material is easily foamed and is resistant to oils, chemicals, and ozone. The unusually high strength, elongation, and resilience are seriously affected by exposure to temperatures above 250° F. for prolonged periods. Probably the greatest use will be in the development of special personnel equipment such as earphone pads, seat cushions, pressure and exposure suits. Other potential uses include oxygen tubing, rain erosion resistant

[16]Esso Standard Oil Co., New York, N. Y.

coatings, strippable protective coatings for parts and aircraft, and other applications where the environment does not include ambient temperatures above 250° F.

Q. What further developments are anticipated for synthetic natural rubber?

A. D'Ianni. This question has been discussed by the panel, who agree it is too early to predict accurately further developments in the synthetic natural rubber. There is no question that the synthesis of natural rubber is of great scientific importance, and a number of rubber and chemical companies are actively following up its development. Plans for pilot-plant construction have been announced by at least one company. It is not felt, however, that rapid commercial development of this polymer will seriously affect the importance of our present general-purpose synthetic rubbers, such as cold and oil-extended cold rubber. These types have definitely established themselves on the basis of performance and cost.

The rapidity of the development of synthetic natural rubber depends largely upon economic factors. Isoprene of high purity, required for this synthesis, is today commercially unavailable. The exact purity required, and the types of impurities which can be tolerated, still remain to be determined. To a large extent we must depend upon the petroleum industry to supply us with the desired monomer at a reasonable cost. Isoprene will probably be somewhat more expensive than butadiene. The development of synthetic natural rubber will be largely influenced by the price and availability of natural rubber.

Q. What are the possibilities of a lower hysteresis polymer for passenger tires?

A. Allen. With the present methods of emulsion polymerization, the possibilities are quite limited. However, Goodrich, Goodyear, and Firestone have announced new low-hysteresis polymers. The problem now is to learn more about them, the raw materials, and methods of manufacture.

Q. How far can synthetic polymers meet the requirements for tires capable of high sustained speeds and/or loads? Considering the limitations of LTP GR-S type polymer, what are the possibilities of improved polymers to produce tires for modern passenger cars of high horsepower and high speeds and turnpike operation?

A. Allen. The GR-S type polymers available today are giving satisfactory service for today's requirements. Even though we have superhighways, current tires are adequate under today's driving conditions where legal speed limits exist and are reasonably enforced. Where speed limits are non-existent or not observed, speeds may range to 95-100 or 105 mph. In these instances nylon reinforced tires are required.

Obviously, continued research will bring forth new and improved polymers which may permit of higher temperatures. The requirement of higher loads, higher speeds, etc., however, involves the entire tire and not the polymer alone. The design, construction, and type of fabric used are also factors which will require time to develop. There is no immediate answer.

A. Evans. We feel that it is quite possible that tires can be produced from butyl rubber to operate on cars of high horsepower and high speeds. This requirement will involve constructing a tire somewhat different from conventional tires, but which would be possible because of the satisfactory characteristics of butyl rubber compounds for this purpose. For example, the tires can be produced using lower cord angle in the body since the flex resistance of these compounds is of such a magnitude that it can withstand the resulting higher strain in the base of the groove. Again, because of the inherent properties of butyl rubber a thinner sidewall and undertread can be used which will give a tire of thinner cross-section and resulting lower heat build-up. These same factors should be important in the building of truck tires capable of high sustained speeds and loads.

Q. How can natural rubber best be made to meet the challenge of higher speeds, heavier loads, and high temperatures in passenger tires?

A. Allen. In view of the many years of experience in compounding natural rubber in order to get the best properties possible, there is no outstanding improvement that can be made immediately. Natural rubber has certain limitations with reference to cracking, oxidation, and aging. Blends with GR-S type rubbers help improve natural rubber with respect to these limitations. New accelerators, antioxidants, carbon blacks, when and if developed, may make it possible to improve these properties in natural rubber.

Q. How can natural rubber best be made to meet the challenge of higher speeds and loads in heavy-duty truck tires? How much can we expect from present and new synthetic rubbers? Do wire cords offer any help?

A. Zwicker. The problems of compromise facing the manufacturer of oil-resistant mechanical rubber goods in developing improved products are multiplied many times for the tire engineer. Anyone who has seen high-speed photographs of overloaded tires at speeds above 70 mph. realizes that problems of better tire construction for such service must include far more than just a better compound or a rubber or a cord. These are important, but so are tire design, construction, sizing, and even vehicle construction. In fact, for the immediate future, better performance will probably have to depend primarily on engineering rather than new materials of construction.

However, with the recent discoveries of how to duplicate the natural rubber molecule, our defense planners can relax a bit. For tree rubber has been the material of choice over all other synthetic rubbers for heavy-duty tires. High-speed, heavy-duty bus-tire service tests on one of these new polyisoprene synthetic rubbers are reported to have gone through the first set of treads without failure and are now running on their first recaps.

So far, wire cord for truck tires has apparently been inferior to nylon for rough road service. Wire cord tires are also more easily damaged by underinflation.

As to the future, we can be sure that competitive research toward a rubber that would be better than *cis* polyisoprene will proceed at an increasing pace. We will simply have to encourage it and await results.

Q. Is the general public or auto industry interested sufficiently in the 100,000-mile passenger tire to be willing to pay a premium price for it? How much premium would you estimate they would pay?

A. Simpson. This is a difficult question to answer. Cost depends so much upon competitive conditions. Certainly it would seem that a tire with 100,000-mile life should be worth some premium if the public can be educated to realize its value.

Q. Are tires with wire cord more easily damaged by improper inflation and/or rough roads than nylon cord tires?

A. D'Ianni. Under conditions of improper inflation, wire cord is more easily damaged than nylon cord. When wire is excessively bent, it fatigues and breaks quickly; whereas nylon can undergo many more flexes before breaking. This fact can be very easily demonstrated by repeatedly banding a wire and a nylon cord and comparing their resistance to breaking.

Under conditions of rough roads, underinflation becomes more critical.

A. Allen. To maintain the same deflection in service as fabric tires, wire tires are normally run at 10 psi. higher inflation. However, extensive testing of wire tires at the same inflation as fabric tires has failed to develop any weaknesses. I'm sure the same thing could not be said for nylon tires run at 10 psi. under rated inflation.

As to improper overinflation, the wire tire would outperform nylon. For heavy overloads the increased inflation is a must, and it is in such service that wire tires have been outstanding.

The reason for this emphasis on proper inflation is that wire tires do not grow with increasing pressures and hence do not exhibit the undesirable overinflation wear characteristics found in nylon and rayon tires.

On rough roads wire tires have better resistance to impact, break, and cutting than nylon and again show better all-around performance.

Q. What will be the effect on the size of the tire market over the next 10 years of the improved, more durable rubbers now being developed?

A. D'Ianni. Over the next 10 years we confidently expect to see an increased and expanding market for both passenger and truck tires, primarily because the number of vehicles on the road will increase steadily. Tires will undoubtedly continue to become more durable, but the service demands will also constantly increase. The net effect will probably be one of an increased tire demand.

Q. What is the future for air cushions in passenger cars?

A. Allen. This question cannot be answered by us as manufacturers, but must be answered by the consumer. It is not clear whether foamed latex seat cushions are included in this question. It is expected that this type of seating will continue to be

used. Owing to the good load carrying characteristics and low permanent set, natural or GR-S type latex blends will probably be used for some time.

A. Simpson. Air cushions are being presented by various manufacturers. Their application will depend greatly upon cost, which now is somewhat high. They are now being used in some truck-seat applications where we hear some claims by the manufacturer for reduction of driving fatigue on long trips.

Q. What non-tire items offer the most promise for additional use of elastomers in automobiles?

A. Simpson. Presently it appears that safety padding of many kinds will use considerable quantities of elastomers. Some manufacturers are using larger quantities of hose. As hydraulic units are added to vehicles, more seals will be needed.

A. Malcolmson. I think there are a number of bright possibilities for elastomers in non-tire uses. Certainly, as power steering becomes more widely accepted, the market for power steering hose (already a rather substantial one) will increase. Expanded acceptance of air conditioning by the consumer public, especially as prices drop further, will increase the need of hose with low permeability to Freon refrigerants.

Another application which is very interesting and on which the automotive industry is expending a substantial amount of effort is the replacement of the steel fuel line with an elastomeric hose or tubing. This, alone, would be a market for some five million pounds of elastomer annually.

In the future, hose use will probably expand some more as more cars find the need of a transmission oil cooling system of some type. Already several car manufacturers are employing transmission oil coolers of one kind or another, most of them with at least a short length of hose in the system.

The extensive interest in the automotive industry in pneumatic suspensions also provides a field of use for elastomers in the future.

Q. What polymers have proved most successful in solving vibration problems in the automotive and aviation industry (particularly air springs)?

A. Allen. Natural rubber, GR-S type rubber, neoprene, and butyl all find application, depending upon the requirements. For engine mountings and other functional parts natural rubber is probably preferred, but GR-S type rubber, neoprene, and butyl are being used, depending upon the specifications for load deflection, resilience, rate of damping, oil resistance, etc.

Q. What is the rubber industry doing about reported failures of airplane tires while taxiing long distances at 30 mph.?

A. Bartholomew. The Air Force has had no reports of failure of airplane tires while taxiing long distances at 30 mph. WADC ran several lab tests on high-ply rating B-47 tires in which they ran the tires for a distance of approximately three miles at 30 mph. and immediately followed this run with a simulated take-off cycle. There were no failures in this test, and the tires were OK'd by WADC. It is the opinion of most observers, however, that because of the high deflection of aircraft tires and subsequent heat build-up, these tires should not be taxied regularly for more than three miles.

Q. Are aircraft tires available that will withstand 600° F. temperatures? If not, how soon?

A. Bartholomew. Assuming that the aircraft tires in question will be exposed to 600° F. for prolonged periods rather than very short times, the answer quite frankly would be *no*.

The Air Force recently initiated several research programs to develop heat-resistant rubber compounds, and until this time very little, if any, data were available on the properties of elastomers while *at elevated temperatures*. Through this effort and the concentrated effort of industry, it is hoped that a good high-temperature elastomer will be forthcoming in not too-far-distant future.

Q. What types of polymers show most promise for such a tire?

A. Bartholomew. The polymers which show the most promise for a high-temperature resistant aircraft tire are: silicone rubber, several acrylates, Kel-F[17] elastomer, and possibly some butyl rubber compounds.

The order with respect to the aging temperature at which 25% of the original tensile strength is lost after heat aging for eight hours of various polymers is as follows:

	° F.		° F.
Silicone	480	Neoprene	325
"Hypalon"	350	Polyurethane	280
FBA[18] polyacrylic	345	LTP GR-S	275
Nitrile	340	*Hevea*	210
Butyl	335	Vyram[19]	embrittled

The temperature *at which* 50% of room temperature tensile is retained follows:

	° F.		° F.
Butyl	330	LTP GR-S	197
Silicone	323	Nitrile	170
Hevea	277	"Hypalon"	163
FBA polyacrylic	277	Neoprene	142
Polyurethane	222		

Q. Will design (construction), compounding, or type polymer be best or quickest solution to this problem of high-temperature airplane tires?

A. Bartholomew. The solution to this problem will undoubtedly require a combination of design, compounding, and polymer research.

Q. What are possibilities of developing tread compounds with good abrasion resistance that will not develop groove cracks when flexed under tension?

A. Evans. By the use of Enjay Butyl in developing tread compounds, the possibilities are excellent that good abrasion resistance can be realized, and at the same time extremely good flex resistance is obtained. This means that a tread produced from Enjay Butyl will not develop groove cracks while being flexed.

A. Malcolmson. This problem, of course, is particularly bad in truck tires with nylon carcasses. Not only is there a good "possibility" of a solution, we feel that a solution is at hand.

It lies in three-elastomer blends of neoprene, natural and GR-S type rubbers. I am sure that some of you have seen test tires with such treads. To illustrate the improvement obtained with this type of compound I'd like to summarize the results of just one of a number of road tests which we have run. This test involved 16 tires in the 11:00x22 size with nylon carcass. The tires were treaded with half and half treads: one-half was the experimental three-elastomer tread, and the other was made with a regular-production natural-rubber tread compound with HAF carbon black. After 60,000 miles the cracks in the tread grooves were measured. Of the natural-rubber half treads, only one had less than 60 inches of groove cracks. That one had 41 inches. The average for the whole 16 tires was 75 inches.

The half treads made from the three-elastomer compound showed a maximum of 1.5 inches of cracking, and the majority of the treads showed no cracking at all. The average for this group, for practical purposes, was 0 inches of cracking.

One tire company has been producing truck treads from this three-elastomer blend since March, 1955. Practically all of the other tire companies have active test programs on such compounds.

Q. What is the present and projected relative status of blacks and non-black pigments as reinforcing agents in transportation rubber products?

A. Evans. In butyl rubber the future of non-black reinforcing agents is very good. Although insufficient data are available, it appears that the abrasion resistance of butyl rubber treads containing certain non-black reinforcing agents approaches that of conventional GR-S type rubber treads.

Non-black reinforcing agents will also become more important as automobile styling requires more colored visible parts.

Q. Where does rubber go when it is worn off tires? Has anyone made a material balance on a wearing tire and identified the products as to solid, liquid, gas, and chemical composition?

A. D'Ianni. To the best of our knowledge no one has ever made a material balance on a tire during its service life and identified the products of decomposition.

There are two schools of thought concerning the abrasion of rubber. One believes that abrasion is primarily a mechanical process dependent upon the physical properties of the stock. The other believes that chemical degradation plays an important role. R. D. Stiehler, of the National Bureau of Standards, who has made a thorough study of abrasion, subscribes to the latter viewpoint, as far as normal treadwear on paved roads is concerned. On the NBS tire tester they have found rubber particles at high rates of wear (treadlife 2,000 to 3,000 miles). They do not have good information for rates of wear usually found in service.

We have made some tests on rubber scrapings collected from highways. It was found that the percentage of rubber col-

[17] M. W. Kellogg Co., Jersey City, N. J.
[18] Minnesota Mining & Mfg. Co., St. Paul, Minn.
[19] Monsanto Chemical Co., St. Louis, Mo.

lected near curves far exceeded that on straightaway stretches. This finding correlates with our tests showing that the rate of wear on curved routes is much higher than that encountered on relatively straight and flat roads.

Q. Will vinyl plastic foams become a significant factor in comfort and impact automotive cushioning?

A. Zwicker. Vinyl foam is already being used in transportation seating because of its low flammability. Recent semi-commercial developments have produced resilient vinyl foam at four pounds per cubic foot, and this grade of vinyl foam is now the lowest cost of the three types of foam materials. However, each type has its advantages and disadvantages; thus we expect uses for all foam materials will expand, including vinyls. The technical advantages of vinyl foams include heat sealability, wide range of firmness and resiliency (impact energy absorption), superior solvent, grease, and chemical resistance, sunlight and moisture aging, as well as color range.

Deficiencies at the present state of technology include higher compression set at 158° F. (excellent up to 125° F.), lower resilience at low temperatures, and the fact that a heat cure rather than room temperature cure is necessary (although it is very rapid). Plasticizer migration has been minimized with recent developments. Load carrying and tear properties are intermediate between unaged rubber and polyurethane foams, but the excellent aging properties of vinyl foam give it the advantage in many applications.

Synthetic Rubber Theme of Fisher Paper at California

Harry L. Fisher, professor of chemical engineering and head of the department of rubber technology at the University of Southern California, addressed 70 members and guests of the Northern California Rubber Group meeting at the Leamington Hotel, Oakland, Calif., January 12. His subject was "The Synthetic Rubber Age."

Preluding his discussion of the new synthetic rubbers, Dr. Fisher pointed out that by the end of 1956 the United States will be producing about 42% of the world's natural and synthetic rubber supply and consuming 61%.

Of the new synthetics, diisocyanate-polyester rubbers appear to have the most promise, showing a two- to four-fold improvement in abrasion resistance, compared to the best natural or cold synthetic rubber tread stocks, the one-time Charles Goodyear Medal winner declared.

He said that in the production of tires from this type of rubber, the principal problem is bonding the diisocyanate rubber to the natural or synthetic carcass stocks, with the solution to this problem not too near. Such improved treadwear was seen vital for the higher speeds of vehicles on our future freeways and express highways.

Showing samples of the new synthetic polyisoprene rubber, Dr. Fisher said that this duplication of tree-grown rubber was achieved through the use of colloidal lithium metal as catalyst. The rubber had a 93-94% isoprene composition, the molecules of which were linked together in the same geometrical way as natural rubber.

Current indications are that this rubber is equal to natural rubber in low heat build-up in large truck and bus tires, known in the industry as low hysteresis loss. Treadwear has also been rated as equivalent to that of the natural product.

Of another promising new rubber, "Hypalon," a sulfonated chlorinated polyethylene, Dr. Fisher said that this new vulcanizable polymer should find application where chemical resistance and good aging are important properties. The new brominated butyl rubber polymers were also commended.

Officers of the Northern California Rubber Group are L. M. Evans, Mansfield Tire & Rubber Co., president; R. T. Hickcox, The Goodyear Tire & Rubber Co., vice president; Ruth Hatch, Mansfield, secretary; and William H. Moore, Whorton-Jackson, treasurer. Directors are Claude C. Corkadel, Oliver Tire & Rubber Co.; R. C. Claussen, Quaker-Pioneer; Eugene Gador, Oliver; and Halsey C. Burke, Burke Rubber Co.

Newton on Ameripol, Yoran on Vinyl Foam, at Detroit

The Detroit Rubber & Plastics Group, meeting February 3 at the Detroit Leland Hotel, Detroit, Mich., was addressed by Calvin S. Yoran, vice president and research director of Brown Rubber Co., Lafayette, Ind., on "Manufacture and Uses of Vinyl Foam," and by E. B. Newton, manager of polymer utilization research at B. F. Goodrich Research Center, Brecksville, O., on "Ameripol SN."

The 192 members and guests in attendance heard Dr. Yoran outline the properties, compounding techniques, and uses of vinyl foam. It was said that vinyl foam was made possible by the technique of plastisol compounding that stems from Waldo Semon's basic discovery that liquid pastes can be obtained by dissolving resins in plasticizers such as tricresyl phosphate and dioctylphthalate.

Vinyl Foam

The solution of vinyl resins in high-boiling solvents at 340-350° F. is called fusion. The plasticizer must have sufficient solvating effect to keep the resin in solution on cooling to room temperature. The plasticizer is usually used to the extent of 60-120 parts per 100 resin. A combination of two or three types of plasticizers is generally used to get a proper balance of properties.

Dr. Yoran described how a vinyl foam is made in a continuous sheet or molded in the same way as foamed latex or chemically blown sponge rubber. Molded parts may be made with an integral skin of solid vinyl which will reproduce accurately every detail of the mold, such as a leather-like grain, he said.

Products such as the sun visors used in the Ford safety program can be made by heat-sealing vinyl foam to sheets of fabric or vinyl film. Dielectric heating is used, with a cycle of 2-3 seconds' heating, plus a few seconds' cooling. It is also possible to emboss the vinyl skin during the heat-sealing operation.

Ameripol SN

Mr. Newton described the properties of Ameripol SN, a *Hevea*-like synthesized rubber soon to be produced by Goodrich. A synthetic *cis*-1,4-polyisoprene, the rubber is made with a Ziegler-type catalyst acting on an isoprene monomer system. Physical methods of analysis, such as infrared spectra and X-ray diffraction patterns, show that its configuration is the same as that of tree-grown rubber.

Ameripol SN processes as *Hevea* does and has the same good building tack, the Goodrich researcher declared. After a small addition of lecithin and triethanol amine to act as a buffer material, the stabilized polymer produces vulcanizates in standard stocks showing physical properties, such as stress-strain and low hysteresis values, like those of similar *Hevea* rubber vulcanizates.

The performance of 11.00 x 20 heavy-duty tires, made entirely of Ameripol SN, was said to be comparable to that of similar *Hevea* rubber tires run in indoor tests, in controlled road tests, and in intercity high-speed bus service.

Ameripol SN also compared to *Hevea* in Mooney viscosity, physical appearance, and in other properties, according to Mr. Newton. Samples of the rubber are not yet available for general appraisal, but will be as soon as the Goodrich pilot plant now being built will go into full production.

Connecticut Group Elects

The Connecticut Rubber Group has elected James Boyle, Armstrong Rubber Co., and Harry Gordon, Bond Rubber Co., chairman and vice chairman, respectively, for 1956, its tenth year of existence. Also chosen were R. T. Zimmerman, R. T. Vanderbilt Co., treasurer; and W. R. Bull, The B. F. Goodrich Co., secretary.

Directors elected were G. A. Di Norscia, Goodrich; Warren Carter, Pequanoc Rubber Co.; B. M. Fairbanks, General Electric Co.; Otto Lang, K.B.C. Industries; and G. B. Jerolman, Armstrong. Lang and Gordon were appointed educational chairman and publicity chairman, respectively.

The Group's executives met on January 20 to discuss plans concerning a forthcoming anniversary dinner to commemorate the founding of the organization and to honor past chairmen.

Akron Group's "Automation—Rubber Manufacturing" Symposium—III

Questions and Answers

Q. Should we expect automation to influence substantially the development of new tire compounds? Will current compounds have to be materially modified in order to conform to automatic systems?

A. Brothers. We have no actual experience on effect of automation on tire compounding, but as judged by our experience in mechanical goods, we would say that the accepted tire compounds now used could be mixed automatically. If this automation is carried into the building and curing operations, we feel that substantial changes might have to be made in the compounds in order to control rate of cure.

Q. Will automation reduce physical handling of the stock by workers to the extent that compounding ingredients of greater toxicity would be tolerated?

A. Hale. The fundamental principle of automation is to reduce the number of contacts between worker and material. Raw materials proceed, without manual assistance, from bins through scales and into the mixer. Current engineering and machine development efforts are directed toward the reduction of all mixed stocks into pelletized, or a flowable condition, so that they can be conveyed to bins over automatic mills for feeding extruders or calenders.

Q. Is high-pressure mixing in internal mixers recommendable for all kinds of rubber compounds?

A. Comes. The high-pressure mixing principle does apply to all types of rubber compounds.

Q. Discuss high-pressure *vs.* regular Banbury mixes from the following viewpoints: (a) processing as might be defined for a precision extrusion; (b) dispersion and physical properties of compound; (c) product quality such as tread wear.

A. Comes. You can do anything with a regular Banbury that you can do with a high-pressure Banbury, but you cannot do it so quickly. There is the one possible exception of the upside-down mix, which is loading all the material together into the Banbury at the same time. The reason this type of mixing cannot be done in a regular Banbury is that you do not have enough horsepower available to run the mixer with the load involved.

Q. What factors must be automatically controlled to promote uniform tread extrusion?

A. Bosomworth. Many factors may have an effect on uniform tread extrusion. Starting with the feed strip we should have substantially uniform plasticity and temperature, and this strip should be delivered at a uniform weight per minute.

Probably the tread tuber itself should have some form of temperature control. The type of screw and steady and minimum clearance between screw and housing interior are additional important factors. Perhaps we should also have a pressure indicator for stock pressure in the tuber which would permit checking for variations due to plasticity and clearance. The conveyor system used should respond to the speed of extrusion so that excessive mechanical compression or stretch of the tread does not occur. Continuous weighing of the tread strip is also an old and necessary practice.

It will probably be possible in the near future to buy some form of gamma-ray gage which will present the operator with a picture of the tread section. This gage will be a help in setting up operating conditions, particularly tuber speed, die shape, and conveyor speeds. When a dual tuber is used, the problem is increased, owing to the difficulty in matching tuber speeds.

Q. Can Banbury automation be considered economical for those operations which require mixing of several different recipes frequently?

A. Brothers. Naturally, the longer the production run on any given compound the more efficient the operation. We feel that runs of 12 batches or less are uneconomical. It requires approximately 10 minutes to set up the control board and check the weights on the initial batch. Some of this time can be saved during the mix of the prior batch. The normal precautions must be followed in Banbury clean-up between batches, and there are no savings in this operation. Production schedules should be projected beyond a 24-hour period rather than a daily period for economy.

Q. In designing a rubber goods manufacturing plant using automation principles, the most difficult part is the physical handling of uncured rubber and rubber compounds. What techniques have been developed for such handling, and what are their limitations?

A. Hale. I presume this question involves the limitations involved in pelletizing and handling of uncured rubber, and also cured stocks.

Today natural and synthetic rubbers are being plasticized and pelletized in one operation. The heat generated in the stock during processing must be fully removed before storage. A limitation is storage of the pellets under too high a pressure or at too great depth.

Limitations in connection with the pelletizing of cured stocks are being removed by new-type pelletizers which extrude and evacuate the batch from the machine almost completely.

Development is currently progressing toward a machine which will automatically mass these finished mixed stock pellets to a very high degree of uniformity and serve an extruder. In addition to automatic handling from storage to extruder, it is also expected that fed-in stock, with uniform plasticity, will assist the extruder in producing an extrusion with continuous and uniform gage or cross-section.

Q. What is the best means of control of the mixing cycle, temperature, time, or both, or other factors?

A. Comes. You can use either time or temperature in dumping a batch from the Banbury mixer. They run hand in hand especially in high-pressure mixing, and it is always a good idea to have the batch dumped automatically when a certain temperature is reached.

Q. What is the best method of temperature control of calenders for skim stocks?

A. Bosomworth. The best combination of control and heating medium for drilled rolls is circulated water, in my opinion.

There are systems which maintain fixed water temperatures, and others where the temperature of the water is varied in accordance with changes in the roll temperature. I believe that the latter system is better. In one variation of this method there is one circulating pump of 75 gpm. capacity and two heat exchangers for high (275° F.) water sources.

The piping is so arranged that direct circulation without going through the heat exchanger is possible, or partial or complete circulation through one of the heat exchangers is permitted. At no time does the output from both heat exchangers enter the circulation loop.

The roll temperature sensing device can be a Leeds & Northrup roll surface thermocouple.

Q. What has been done to handle warm stock after it has been cut to the desired blank size from the calender or tuber?

A. Brothers. The first step in such an operation is one of cooling since the colder the stock, the less it will distort. On calendered blanked sheets, anti-stick is mechanically applied, if desired. Adhesive cements can also be applied mechanically. Soft extruded stocks still need to be hand stacked in pans or liners or placed in forms to prevent distortion.

Q. How far has the automation of curing processes progressed, including loading and unloading—discuss manpower and servicing problems involved?

A. Torrey. The degree of automation which has been reached generally in production processes was dealt with in our introductory remarks, where we showed that all the operator had to do was drop a tire into an automatic press and punch a button—since automatic stripping and take-away is now an accomplished fact.

Even without this latter arrangement it is entirely practicable for one operator to handle up to 33 dual presses, each operating on an 18½-minute cycle. The advantages to be gained from increasing the number of presses per operator by further reduction of cure time are problematical.

Means for the automatic blowing-out of molds is available now, and it might be quite feasible to load these presses automatically and eliminate the operator entirely.

We maintain, however, that it is essential that the operator observe the critical shaping operation and give the bladder at

least a cursory examination after each cure. By this means he can detect irregularities or difficulties in the making and call for correction before a succession of questionable or defective tires is produced. Three more spoiled tires a shift, out of a single operator's potential production of about 1,300, would more than offset the cost of the operator.

Some further reduction in curing times can be anticipated, but until control valves and timers can be developed to a degree of perfection which is not even in sight now, we can see little prospect of eliminating this press operator—and even if these mechanical improvements were made, we might easily find ourselves in the position of trading an operator for a mechanic.

Q. Which type of beta-ray calender control gives us the most uniform results on cord fabric; transmission, reflecting, or a combination of the two? Will the control be satisfactory in cases where the width varies or the cord count is not uniform?

A. Bosomworth. I believe that the tire engineer would like to expand the question to include the control of fabric gage or thickness. The choice of transmission or back scatter gages seems to me to be tied in with the decision to go after either uniform gum weight or uniform total weight per square yard. The former would require the back scatter gage, and the latter the transmission gage. If there are significant variations in cord count throughout the length of the fabric, then it would appear that back scatter gages would be preferable. If only cord width varies, then it doesn't matter too much which gage is used. Personally, I prefer the transmission gage.

The overall fabric thickness after the first- and second-pass calenders should be measured and controlled. In my opinion the magnetic gage is the correct one to use for this purpose.

Q. Have any methods been proposed to maintain continuity of operation between fabric calendering and tire building?

A. Bosomworth. I am not sure how much progress has been made in plans to insure continuity in material flow between the calender and the building machine. The degree of success of this type of operation depends on the ability to schedule long runs of the same-size tire, preferably with the same ply width. Since the calender can produce more fabric than the bias cutters can handle, we have to find a way to feed the fabric into, say, two or three compensators each in line with separate bias cutters, followed by automatic splicing of stocks and storage for delivery to the building machine in the case of single ply.

This-type operation envisages some type of roll let-off at the building machines. A somewhat similar system might be set up for band building where the bands are built right at the tire machines.

An alternate in the case of single ply would be to cut automatically the fabric to length and have the individual plies served to the machines by a belt. This-type operation has very limited application for one-size tire operation. If we tie a row of building machines down to one-size tire for a period of time, to help the automation picture then we would have to solve the green-tire storage problem or the problem of a large inventory of molds where the production ticket is for different tire sizes.

Q. What is the shortest cure possible for 7.10-15 rayon, and 7.10-15 nylon tires, in Bag-O-Matic presses?

A. Torrey. Using bladders of the current conventional design, 7.10-15 rayon nontubeless tires have been cured successfully in cycles of between 17 and 18 minutes. Tubeless tires generally require a couple of minutes longer.

Even shorter cures may be achieved by using thinner bladders, higher curing temperatures, and more acceleration in the compound, but the net gain from any such further reduction is problematical, as all of these factors tend to increase defect percentages, and the higher temperatures make the cure much more critical and may even adversely affect the durability of the carcass material.

Insofar as the process of vulcanization is concerned, there is no essential difference between the requirements for rayon or nylon tires. The fact that nylon has a much greater tendency to shrink after cure, however, makes it necessary to subject nylon tires to a lengthy period of cooling (such as by circulating cold water through the bladder) before releasing the internal pressure. So the total *cycle* for nylon is likely to be 10 minutes or more longer than for rayon.

Q. What are the shortest curing times for mechanical goods compounds, for instance, automobile windowstrip extruded section?

A. Brothers. This is rather a difficult question to answer in just a few words. In general, the shortest time would be in the range of one minute or less. It is possible to develop compounds that can be handled by conventional equipment that will cure in this time. Other factors enter into the problem, such as speed of loading and unloading molds. If molds are allowed to cool during this operation, the curing cycle must be lengthened in order to get the equipment back to the curing temperature. Cross-section as well as size of the part must be considered.

Some experiments are under way relative to curing continuously automobile windowstrip sections, but all problems have not been solved. Proper vapor locks need to be designed in order to retain the steam within the curing area, and these curing areas are of abnormal length because of the cross-section of the weatherstrip. If optimum quality is not required, and if the part in question is not too tacky or too thick, it is possible to extrude through a vapor system having a high concentration of secondary accelerator and then wind up the extrusion on itself for room-temperature cure during storage or shipment.

Q. Has automation been applied to transfer, injection, and compression molding of rubber parts?

A. Brothers. We feel that injection and transfer molding is a form of automation for compression molding. In this sense the press does the actual job of filling the cavities. We know of no other application of automation principles.

Q. What are the latest thoughts on "flood" *vs.* "spray" jacket cooling for high-speed, high-pressure Banburys?

A. Comes. We have run an exhaustive series of tests on cooling and have found that "flood" with jets of high-pressure water passing through the Banbury to wipe off the B.T.U. from the surface in contact with the stock gives the best type of cooling.

Q. Banbury stock mixing is a batch or discontinuous-type operation. Are there any new-type mixing machines which lend themselves to continuous mixing?

A. Comes. In my opinion no continuous mixer on the market can make a perfect mix. Some continuous mixers can mix the stock well enough. Of course it is the desire of everyone to mix continuously. We are trying out different types of screw machines for continuous mixing and at present are installing a special German machine designed for this type of work. However, I do not believe anything will quite equal the mixing efficiency of a batch machine. The high-pressure Banbury on the extremely short cycle with a screw machine under it can provide a continuous output.

Q. What is the reason for differences in physical properties between a low temperature, longer cure *vs.* short, high-temperature cure, for example, 60 minutes at 280° F. *vs.* 17 minutes at 315° F.?

A. Torrey. If each stage of each cure is properly determined and accurately controlled, the physical properties and performance potential of the tires produced by each are the same.

But with any short, high-temperature cure, a deviation in time or temperature, of a magnitude which would be of small consequence with the long, low-temperature cure, can produce a notable difference in results with the former.

The more critical nature of the shorter cures manifests itself primarily as a tendency toward a higher percentage of surface defects.

Q. (1) What is the industry status with regard to continuous vulcanization of extruded goods (other than insulated wire)?

(2) Please discuss continuous molding as recently publicized. Publicity indicated that molded strips could be made long enough to go "around the world." What type of machinery is used? What compounding problems arise?

A. Brothers. In answer to the first question, some manufacturers are using the principle of continuous cure for some mechanical goods parts. This work is not as far advanced as in the insulated wire industry, but production parts are being made in this manner. Standard warm-up mills and tubers are used, with either steam or hot air as the curing medium. The prime problems here have to do with length of heater, speed of conveyor belt, and temperature involved. The peculiar compounding problems that arise are those of obtaining a fast enough cure to complete it in the curing oven and still slow enough to prevent set-up during the forming state.

In regard to molding continuous strips, this is usually done in a mat-type platen press. Splices are made in the press between

the end of the first section and the start of the second section. In this manner these strips can be produced in endless lengths.

Over the past few years development work has been carried out in which high-frequency heating units have been used for curing rubber products. To date, these have not proved completely trouble free.

Q. How are some of the products made by rubber companies contributing to automation in other industries?

A. Bosomworth. Probably more than we realize the products of the rubber industry find their way into other fields of automation. For instance the tubeless tire has proved to be a big help on the assembly lines of the automobile companies. In this case the tire can be inflated to full pressure in two or three seconds, with the valve cap in place.

Another example of the use of rubber products is that of diaphragms for control valves. Then there are the applications of V-belts, shock absorbers, and Fawick clutches for automatic machines. There are also molded rubber parts for electrical switch gear and, of course, wire covering for electrical circuitry, rubber covered rolls for printing and conveyors, and belting for weigh scales and conveyors. If one takes into account the non-rubber products of the various companies, the list could be greatly increased.

Q. How does the maintenance cost on high-pressure Banbury mixing compare with conventional-speed Banbury mixing?

A. Comes. The maintenance cost on a high-pressure Banbury would not be any more per pound of stock mixed, and from the experience we have had to date we believe the cost per pound will be less.

Q. What does it cost to equip completely a size 11 Banbury with automatic weighing facilities together with controls and interlocking electrical mechanism to operate the mixer itself?

A. Hale. The geographic arrangement of bins, scales, and Banbury hopper feeder can vary the initial cost considerably.

All the bins, feeders, and scales necessary for handling, say, four types of black, oil, and rubber pellets together with eight types of bulk pigment, and 12 types of small-volume powders, would cost probably $150,000. A large part of this cost would be master control panels and interlocking devices for automatic operation of the Banbury mixer.

This capital investment is not justified entirely through labor savings, but to a large extent from the elimination of extruded and calender stock losses caused by uncontrolled weights of batch ingredients. Manual weighing is not dependable.

Q. In changing from the use of a compression-type mold to the use of transfer-type mold, do you have to make any change in the formulation, or can you use the same compound?

A. Brothers. In general, I would say that the same compound can be used. A lot depends upon optimum curing temperatures used. If the compound has to be changed for transfer molding, the extent of the change is very small.

Q. What has automation done to make possible a more uniform tire, with special reference to removal of tire balance and thump?

A. Torrey. I don't think automation has made tires any less uniform. Look back on the tire curing processes formerly used and compare them with our present method of curing in automatic presses. You can all remember the operation of putting the airbags into the green tire, where you buckled the bag in three or four places and then spent about 15 minutes banging some of the buckles out of it. You then put the tire into a mold where it did not center in the mold at all, and you had to push it in some sort of centering arrangement to get the lid on.

In contrast, the tire, when placed in the automatic press, is lined up in such a way that the bladder or airbag, when it shapes the tire, shapes it and centers it almost exactly.

Tires manufactured today are giving outstanding service. Tires made five or six years ago would not operate satisfactorily on the cars of today to suit the car owner.

Q. We conducted some mixing experiments in the Farrel-Birmingham laboratory using neoprene rubber and found that we could not use high rpm, but could use high pressure. Can you get the same results mixing at high rpm and low pressure as you can by mixing with low rpm and high pressure?

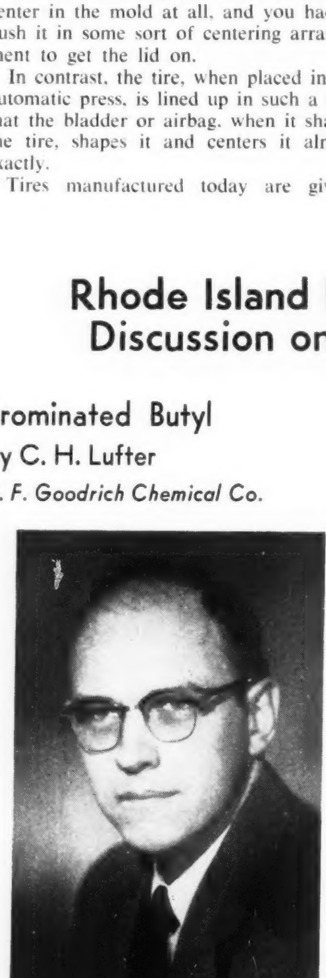
A. Comes. In general, various combinations of rpm and pressure will give the same result in mixing. The horsepower used per pound of stock produced in order to provide the desired results is determined. Various combinations of speed and pressure may be tried, all of which have about the same horsepower input, until the best combination for the stock in question is found. In mixing soft stocks, higher speeds are preferred; stiffer stocks call for higher pressures and lower speeds.

Rhode Island Rubber Club Panel Discussion on Butyl Rubber—III

Brominated Butyl

By C. H. Lufter

B. F. Goodrich Chemical Co.



Madison Geddes

C. H. Lufter

Brominated butyl is a chemically modified form of butyl rubber available commercially as Hycar 2202.[13] It is produced by the incorporation of 1% to 3.5% bromine by weight on the polymer chain. The bromine probably enters the polymer by both substitution and addition.

Brominated butyl is unique first of all in being one of only two commercial polymers produced by using another commercial polymer as a starting point. It is unique, secondly, because some of the traditional difficulties encountered with butyl give promise of being eliminated by its use. For example, butyl traditionally has a slow cure rate; it has an aversion for other polymers which demands extraordinary care in avoiding polymer contamination; and adhesion of butyl to most other substances has always been a problem. It is felt that brominated butyl may solve many problems which now make use of the valuable butyl polymer difficult or impossible in a number of applications.

Compounding

Brominated butyl is compounded in the same manner as butyl with the exceptions that more latitude in the use of softeners or resins is permitted, the presence of other polymers does not retard or inhibit the cure, and reduced accelerator levels are usually indicated. The use of quinoid-type cures tends to give a slightly scorchy stock, and a 25% reduction of the quinone phase plus the dibenzo variation is recommended.

Several cure systems which have been found to be successful are: (1) sulfur 2.0, benzothiazyl disulfide 1.0, DOTG 0.10; (2) sulfur 2.0, benzothiazyl disulfide 0.25, TMTD 0.50; (3) sulfur 1.5, p,p′ dibenzoyl quinone dioxime 4.0, red lead 7.0. (All on 100 parts brominated butyl rubber.)

Brominated butyl may be mixed on a two-roll mill in the same manner as regular butyl rubber. In the case of Banbury mixing, the increased cure activity of brominated butyl requires that the curing ingredients and metallic oxides be added on the sheet-off mill to avoid scorching.

Cure Characteristics

The cure rate of brominated butyl is such that the time to reach a given cure level is one-half to one-third that required with regular butyl at equal accelerator levels. This fact has been shown by Mooney scorch curves where the brominated butyl

[13]B. F. Goodrich Chemical Co., Cleveland, O.

attained a 30-point Mooney increase in one-third the time required for butyl and a polymer blend of 50 parts of butyl and 50 parts of brominated butyl more than halved the cure time found with butyl alone. Brominated butyl vulcanizates, generally speaking, show lower tensile strength, lower elongation, and higher modulus than comparable butyl vulcanizates, along with no tendency toward reversion on overcure.

The unusual cure properties of brominated butyl may be explained in part at least by the dual cure mechanism which exists. A small amount of unsaturation is present, and it is through this unsaturation that sulfur vulcanization takes place. At the same time it is apparent that vulcanization also occurs owing to the interaction of the bromine in the polymer with heavy metal oxides in the compound.

Polymer Blends

Brominated butyl may be blended with natural and GR-S type rubber with good polymer compatibility. Cure systems similar to those customarily used with GR-S and natural rubber have produced satisfactory vulcanizates of the blends. Although natural rubber blends appear to have better cure characteristics than GR-S type rubber blends, both polymers, when blended with brominated butyl, result in vulcanizates with improved ozone resistance.

The ozone resistance of the blends increases rapidly as the ratio of brominated butyl to GR-S or natural rubber increases above the 50/50 level, and at a ratio of 70/30 the blend approaches a maximum ozone resistance level. For example, a blend of 70 parts of brominated butyl in a compound with 30 parts of natural rubber showed no cracks in a stressed specimen after 214 hours' exposure to a 25 pphm ozone concentration.

Adhesion

The compatibility of brominated butyl with other polymers provides an excellent means of solving the difficult problems associated with the adhesion of butyl to other materials. Adhesion of butyl to GR-S or natural rubber can be accomplished by applying a brominated butyl cement to the surfaces of the butyl compound and the GR-S or natural rubber compound and then curing the cemented surfaces together.

The most successful cement for the adhesion of butyl to other polymers has been found to be a simple 10% heptane cement of brominated butyl reinforced with 40 parts of EPC black. Using this system, adhesion of butyl to natural rubber has reached values of 75 lbs./in., and adhesion to GR-S has been found to be 25 lbs./in.

Improved adhesion has been obtained through the substitution of a tie gum or tie coat for the cement. In this case adhesion of butyl to natural rubber at room temperature has been greater than 95 lbs./in., and at 212° F. the butyl-to-rubber adhesion reached 66 lbs./in., at which level the canvas backing on the test samples failed. When the tie-coat technique was used, the adhesion of butyl to GR-S was 56 lbs./in. at room temperature and 23 lbs./in. at 212° F.

Excellent adhesion of butyl to aluminum, brass, and steel can be obtained by the use of a brominated butyl cement. Preparation of the metal surface should follow the usual procedure of sand or grit blasting and degreasing, and this should then be followed with a prime coat of resorcinol-formaldehyde resin. A thin film of brominated butyl cement should be applied to both the butyl and the metal surfaces. The cement recommended is that made from a brominated butyl-EPC black mill mix. After the assembly of butyl and metal has been cured, adhesion values greater than 75 lbs./in. have been obtained at room temperature. Values greater than 68 lbs./in. have been obtained at 212° F. against aluminum, brass, and steel.

Electrical Properties

Brominated butyl, because of its increased cure rate, would seem to offer considerable promise for electrical insulation applications. It has been found that when brominated butyl is put in an insulation recipe, aging, low-temperature flexibility, ozone resistance, power factor, SIC, insulation resistance, and dielectric strength all are about equivalent to those of an electrical grade of butyl. A word of caution is that the water resistance of brominated butyl vulcanizates, although excellent in comparison with most polymers, is not so good as the exceptional water resistance obtainable with regular butyl vulcanizates.

Aging

Butyl vulcanizates have good resistance to high-temperature aging. Comparisons of brominated butyl vulcanizates to regular butyl vulcanizates have shown that, in general, resistance of brominated butyl to high-temperature aging is equal and sometimes superior to that of comparable butyl compounds.

An advantage of brominated butyl becomes evident when certain vulcanizates are aged in air at 350° F. Under these conditions some butyl cures revert so badly as to make determination of physical properties impossible. The quinoid cures have not shown this reversion tendency, and with such systems little difference between the aging properties of butyl and brominated butyl has been found.

Summary

Vulcanizates of brominated butyl rubber retain many of the excellent properties of regular butyl rubber such as ozone resistance, good low-temperature brittleness, low air diffusion, electrical insulation characteristics, and good aging resistance. In addition, the use of brominated butyl eliminates several undesirable characteristics of regular butyl which have limited the application of this latter polymer. Brominated butyl provides a faster cure rate, affords compatibility with a number of elastomers, and gives excellent adhesion to metals and other polymers.

Questions and Answers

Q. Has there been developed a suitable cement for cementing two pieces of butyl rubber together?

A. Lufter. Assuming that the question refers to adhering two pieces of cured butyl, the answer would be that it is difficult to formulate an adhesive to give a good bond strength under such conditions. A fair bond may be obtained using a reclaim butyl, brominated butyl, or even natural rubber in the presence of heat and pressure. Satisfactory adhesion of uncured butyl to uncured butyl can usually be accomplished by using a butyl cement made from a composition similar to the butyl compound being cemented.

Q. Is it possible to blend butyl with another polymer?

A. Efforts to blend butyl rubber with other polymers have usually failed because of the unsatisfactory cure which results from these butyl blends. Successful blends with neoprene have been reported, and blends of butyl with brominated butyl present no problem. Some success has been had with three-way blends of butyl, brominated butyl, and natural or GR-S type rubber.

Brominated butyl may be blended in all proportions with GR-S, natural rubber, or Hypalon.[14] There have been recent reports in the literature of successful blends of butyl with other polymers accomplished by the use of selected cure systems.

Q. What is the best cement for adhering cured and/or uncured butyl to metal? What is the effectiveness of these adhesives at 250° F?

A. Excellent adhesion of butyl to metal can be obtained by using a simple 10% hexane cement of brominated butyl reinforced with 40 parts of EPC black. When such a cement is used between a prime coat of resorcinol or phenol formaldehyde resin and the butyl compound, adhesive strengths of greater than 75 lbs./in. can be obtained. Adhesion of these bonds at 250° F. have exceeded the capacity of the test instrument and were recorded as being greater than 68 lbs./in. These tests were run with uncured butyl that was vulcanized in place against aluminum, steel, or brass.

Q. What are the electrical characteristics of brominated butyl?

A. The electrical characteristics of brominated butyl are good. A recent publication has shown that when brominated butyl is compounded in a typical insulation recipe, it is equivalent to the best electrical grade of butyl in power factor, SIC, insulation resistance, and dielectric strength. It should be pointed out that the mechanical water absorption of brominated butyl is greater than that of butyl, which has an extremely low water absorption. This increased water sensitivity may alter electrical characteristics obtained after extended periods of exposure in the presence of water.

Q. What are the moisture absorption characteristics of brominated butyl?

A. The water absorption characteristics of brominated butyl are good by most standards, but the swell of brominated butyl compounds in water is several times that of regular butyl, which has an exceptionally low water absorption. A recipe which gives a volume change in water of 0.5% with butyl will give about 4% with brominated butyl.

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[14]E. I. du Pont de Nemours & Co., Inc., elastomers division, Wilmington, Del.

Butyl Reclaim

By G. A. Barclay

Xylos Rubber Division, Firestone Tire & Rubber Co.

G. A. Barclay

Many articles are made from butyl rubber. For various reasons some of these articles will find their way into a reclaimer's plant, and it then becomes his problem to process this scrap into a workable reclaim.

At the present time we are using butyl tubes as the main source of scrap since they have been the high-volume item. Butyl tubes are reclaimed under exacting specifications using very small amounts of reclaiming oils. The butyl reclaim has a low Mooney plasticity, high rubber hydrocarbon content, and excellent workability.

One of the main difficulties found in reclaiming butyl scrap is avoiding contamination by other types of rubber scrap, and it is necessary to examine completely every lot of butyl scrap used for this purpose. The examination employs a rebound test or an odor test of a sample when burned. We have trained people to recognize butyl by these tests, but it entails a considerable amount of work. A simpler method is identification by means of the blue line on the butyl tubes. The reclaimers would appreciate having all butyl parts marked in such a manner. It is also necessary to examine for patches on the butyl tubes as these represent a possible contamination.

One to 5% of contamination by other types of rubber, natural or synthetic, will result in butyl reclaim with a very low rate of cure. The other natural or synthetic rubbers have a greater affinity for the curatives in a given compound, thus causing the butyl reclaim in it to cure more slowly. We have cautioned the users of butyl reclaim to store it in a separate place away from other reclaims since mixing of butyl reclaim with other types of reclaim in the customer's plant will result in these same poor cures.

Butyl reclaim represents a completely mixed formula with the contained pigments completely dispersed. Butyl reclaim accepts additional pigments readily. For some products it is only necessary to add the curatives, and therefore a batch can be mixed in only a few minutes. If it is desired to mix butyl reclaim with new butyl rubber, butyl reclaim will aid in the acceptance of pigments such as carbon black, thus reducing the mixing time. The nerve of a butyl reclaim compound is much less than that of a new butyl compound, and by the use of butyl reclaim better smoothness is obtained. For this reason butyl reclaim is widely used in calendering and tubing compounds.

Butyl reclaim requires more ultra-accelerators than other types of reclaim. One explanation for this situation is that butyl originally has a low unsaturation. Some of this unsaturation was used up in the original cure (before reclaiming), and after reclaiming less unsaturation is available for the cross-linking by sulfur. When butyl reclaim is used with new butyl rubber, however, no greater amounts of curatives are necessary than would be used in an all-new butyl formula. Use of butyl reclaim with new butyl will enable the compounder to reduce the total plasticizer, carbon black, and other fillers in a compound in proportion to their amount in the reclaim.

Some of the accelerators that may be used for curing butyl reclaim follow: Methyl Tuads,[11] Captax,[11] Ethyl Selenac,[11] Polyac, and many more. These are used in conjunction with five parts of zinc oxide and two parts of sulfur, based on 100 RHC. Butyl reclaim, when tested in the following rubber reclaimer's formula, will give tensiles of 1,000 to 1,500 psi. with an elongation of 500-600% and a Shore A hardness of approximately 50:

	Parts
Butyl reclaim	182
Zinc oxide	5
Sulfur	2
Methyl Tuads	1
Captax	0.5

Cure 20 minutes @ 320° F.

This formula indicates one of the combinations used for curing butyl reclaim.

Several types of butyl reclaim made by different methods and addition of pigments are available. These reclaims differ in properties and are made for various end-uses in butyl tubes, hose, and mechanical goods. The type of butyl reclaim to be used depends on the mixing formula and the properties desired in the finished product.

Permeability of butyl compounds is not affected to any large degree by the addition of butyl reclaim.

Another possible use for butyl reclaim is in cements and dispersions. In cement work the aromatic solvents such as toluene seem to be the best; while the hydrogenated solvents such as Talloc or Apco #1[15] are second best. Cements with total solids of 10-25%, depending on viscosity required, can be made.

Any reclaimer will be glad to work with compounders in connection with the use of butyl reclaim, if requested.

Questions and Answers

Q. Can butyl reclaim be blended with other rubbers?

A. Barclay. There are times when a mixture of butyl reclaim with other rubbers would fulfill a purpose. On blends containing 50% of a butyl reclaim and 50% of a natural rubber reclaim a tensile is obtained approximately one-third of the calculated tensile from cures containing 100% of each reclaim. The best results are obtained by the use of 1.5 to 2.5 parts of sulfur along with 1.0 to 1.5 parts of a mild accelerator such as Altax or Santocure.[16]. There are probably other combinations of curing ingredients that may be used; however, the resulting compound will have a low tensile value.

From the data we have obtained it appears that mixtures of 1-5% of natural rubber in butyl reclaim will cause a considerable decrease in tensiles and may result in spongy cures. Increasing the percentage of natural in the butyl reclaim with proper curatives will still give low tensile figures, but without spongy cures.

Q. What is the future availability of butyl reclaim?

A. The use of the tubeless tire on automobiles has reduced the use of butyl tubes and the main source of butyl scrap. For the immediate future most reclaimers have enough scrap to fulfill customer requirements with the present grades of butyl reclaim.

Beyond this point the availability of butyl reclaim will depend on the use of butyl rubber in various other products since part of these products will eventually end in the reclaimer's yard. Provided enough volume is obtained from these parts a good butyl reclaim can be made. If these butyl parts could be marked in such a way as to recognize them at sight, it would greatly help the reclaimers supply a good butyl reclaim. An example of the desired-type marking is the blue line used on butyl tubes.

As the characteristics of reclaim are controlled to some degree by the scrap used, this new butyl reclaim may be slightly different in analysis from the present types of butyl reclaim. We feel sure, however, it will give the same easy processing as the current butyl reclaims.

Q. Does butyl reclaim improve processability, mixing, calendering, extruding?

A. It has been our experience that formulae using butyl reclaim process quicker and require less mixing time than those formulae using all-new butyl rubber. This advantage is attributed to the reclaiming process since it provides means for control of the Mooney viscosity and the smoothness of the finished reclaim. Also, remember that since the plasticizing oils, carbon black, and fillers already are mixed and dispersed in the butyl reclaim, further compounding may require only the time required for addition of curatives.

By virtue of the reclaiming process the "nerve" or the tendency of a compound containing butyl reclaim to shrink is greatly reduced. For this reason compounds using butyl reclaim in the proper formulations will calender and extrude faster and smoother than a similar compound using all-new butyl.

[15] Anderson-Pritchard Oil Corp., Oklahoma City, Okla.

[16] Monsanto Chemical Co., rubber chemicals department, Akron, O.

Substitution of butyl reclaim for all or part of the RHC into formulae now using new butyl rubber will result in easier processing. With this substitution it will be necessary to take into account the oils, carbon black, fillers and RHC values which are present in the butyl rubber reclaim.

Questions Submitted to and Answered by Enjay Co., Inc.

Q. What are the recommendations for type recipe for making a high gum butyl rubber, non-blooming, non-tacky, light-colored compound?

A. For a non-blooming stock use: (1) high degree of bound sulfur, (2) minimum amount of sulfur, and (3) readily dispersed sulfur, such as Spider[17] with or without Sulfasan R.[16]

For reduction of tack use: (1) MgO, and (2) heat treatment.

Q. How may maximum tensile from pure gum butyl stocks be obtained? How high is this tensile?

A. For maximum tensile, Enjay Butyl Grade 035 or 150 should be used. A cure system composed of ZnO, Tuads, and sulfur is also suggested. With Enjay Butyl Grades 035 and 150, a tensile of 3,500 psi. can be attained. Use of Enjay Butyl 218 results in a tensile of about 2,400 psi.

Pure gum stocks tend to have poor tear resistance; consequently tensile data are difficult to obtain. Usually a loading of 10 vol. % carbon black phr is employed for test purposes.

Q. What types of carbon black give best abrasion resistance, and for what percentage of black?

A. Channel blacks used to the extent of 35-50 phr give the best abrasion resistance. Forty parts of SAF black with 15 parts oil are also satisfactory.

Q. What effect does soapstone, soap solution, and zinc stearate have on butyl stocks prior to curing?

A. Soapstone has no effect; however, it may cause mold sticking upon curing; soap solution has no effect and should give good mold release; zinc stearate has no effect, is absorbed by the polymer, and is a good lubricant.

Q. What effect does water have on butyl stocks prior to curing?

A. No effect.

Q. How is maximum ozone resistance obtained in a butyl vulcanizate?

A. Maximum ozone resistance for a butyl vulcanizate is obtained with: (1) high state of cure; (2) low polymer unsaturation; (3) Tuads-Captax-Sulfasan R-sulfur cure system; (4) good sulfur dispersion—use of Spider sulfur; (5) low black loadings—use of furnace and thermal blacks.

Q. In sulfur thiuram cures on black butyl wire jacket stocks, what can be done to improve the slow recovery from deformation?

A. A higher state of cure would improve this resistance to deformation, as would heat treatment. The use of Polyac in the cure system may also be an aid.

Q. What is the best way to combine butyl with either polyethylene or polyvinyl chloride?

A. For blending polyethylene with butyl rubber: (1) masticate butyl; (2) add polyethylene to butyl above 320° F. and make a masterbatch containing 30% polyethylene; and (3) take an aliquot of Step 2 and blend to desired level.

Q. What effect does thermal interaction have on the physical properties of a butyl compound when clay loadings are used instead of carbon black?

A. Heat treatment results in (1) increased tensile strength, modulus, and resilience, and (2) reduced stiffness, permanent set, and extrudibility.

Q. Discuss compatibility and properties of polyethylene-butyl mixtures.

A. Mixtures containing large amounts of polyethylene, when poorly mixed, tend to be granular on extrusion and blowing.

[17]Rubber makers sulfur, Olin Mathieson Chemical Corp., Industrial Chemicals Division, Baltimore, Md.

Five-Day Elastomers Conference Slated for Gordon Research Series; Schedule 14 Papers

The Gordon Research Conferences of the American Association for the Advancement of Science for 1956 will include a conference on elastomers to be held at Colby Junior College, New London, N. H., July 30-August 3. The entire series, scheduled for June 11-August 31, will consist of 36 separate conferences covering a wide range of scientific research.

The Conferences were established to stimulate research in universities, research foundations, and industrial laboratories. Morning and evening sessions will be devoted to the reading of papers, with afternoons being retained for recreation and other informal activities.

The series will be held at New Hampton School, New Hampton, N. H., and Kimball Union Academy, Meriden, N. H., in addition to Colby Junior College. Attendance at each conference is limited to 100.

According to W. George Parks, director of the Gordon Research Conferences, the scheduled program is geared to bring experts up to date on latest scientific developments, analyze the significance of these developments, and provoke suggestions as to underlying theories and profitable methods of approach for making additional progress.

B. S. Biggs, Bell Telephone Laboratories, is chairman of the elastomers conference. E. E. Gruber, The General Tire & Rubber Co., is vice chairman. The following authors and the subjects of their papers have been scheduled for the elastomer conference:

July 30: S. N. Muchnick, The Franklin Institute, **"Adhesive Bonding of Metals"**; D. M. Alstadt, Lord Mfg. Co., **"Fundamentals of Rubber Adhesion"**;[1] S. M. Ohlberg and L. E. Alexander, Mellon Institute of Industrial Research, **"Crystallinity and Orientation in Organosiloxane Polymers—X-Ray Diffraction Studies"**; E. L. Warrick, Mellon Institute, **"Crystallinity and Orientation in Organosiloxane Polymers—Physical Measurements."**

July 31: Giulio Natta, Instituti di Chimica Industriale del Politecnico, **"Synthesis by Anionic Polymerization of New Elastomers and Unsaturated Crystalline Polymers"**; W. S. McNatt, California Institute of Technology, **"Biosynthesis of Rubber."**

August 1: R. M. Pierson, The Goodyear Tire & Rubber Co., **"Formation and Properties of Networks Involving Addition Polymers Having Reactive End Groups"**; H. Westlinning, Werk Kalscheuren, **"Interaction between Rubbers and Fillers"**; G. Kraus, Phillips Petroleum Co.; **"The Significance of Swelling Equilibria in Carbon Black Reinforced Elastomers."**

August 2: J. W. Sellers, D. Inman, and M. P. Wagner, Columbia-Southern Chemical Corp., **"Reinforcement by Fine Particle Silica"**; I. Auerbach, W. C. Kuryla, and S. D. Gehman, Goodyear, **"A Diffusivity Approach for Studying the Molecular Structure of Elastomers"**; L. Mullins, British Rubber Producers' Research Association, **"Recent Developments in Theories of Elastic Behavior and Mechanical Failure of Rubber."**

August 3: K. W. Scott, Goodyear, **"Dynamic Properties of Strained Elastomers"**; J. P. Berry, University of Akron, **"Stress Relaxation of Natural Rubber Vulcanizates."**

The dates and subjects of the entire series of Gordon Research Conferences are as follows:

June 11-15, Catalysis, Organic Reactions and Processes, Lipids; June 18-22, Petroleum, Metals at High Temperatures, Stream Sanitation; June 25-29, Separation and Purification, Proteins and Nucleic Acids, Nuclear Chemistry; July 2-6, Polymers, Coal, Chemistry and Physics of Isotopes; July 9-13, Textiles, Radiation Chemistry, Solid State Studies in Ceramics; July 16-20, Corrosion, Organic Coatings, Bones and Teeth; July 23-27, Instrumentation, Chemistry and Physics of Metals, Chemistry at Interfaces; July 30-August 3, Elastomers, Steroids and Related Natural Products, Ion Exchange; August 6-10, Food and Nutrition, Analytical Chemistry, High-Pressure Research; August 13-17, Vitamins and Metabolism, Inorganic Chemistry, Toxicology and Safety Evaluations; August 20-24, Medicinal Chemistry, Statistics in Chemistry and Chemical Engineering, Infrared Spectroscopy; August 27-31, Cancer, Adhesion, Glass.

Requests for attendance at the Conferences should be addressed to W. George Parks, Director, Department of Chemistry, University of Rhode Island, Kingston, R. I. Applicants must state their company or institutional affiliation and their subject of major interest.

[1] Rubber World, Nov., 1955, p. 211.

Maassen on Antioxidants at Tlargi; Beckman Also Talks

G. S. Maassen, R. T. Vanderbilt Co., New York, N. Y., spoke on "Antioxidant Evaluation" before the February 7 technical meeting of The Los Angeles Rubber Group, Inc., at the Hotel Statler, Los Angeles, Calif. After-dinner speaker was Arnold O. Beckman, Beckman Instruments, Inc., Fullerton, Calif., who discussed the industrialization of southern California.

Mr. Maassen traced the development of rubber aging equipment in this country, discussing such items as the Geer oven, the oxygen bomb of Bierer and Davis, and U. S. Rubber's air bomb—all in use before the advent of the 1930's. These did not yield optimum evaluation.

The air bomb, for example, a means of simulating service conditions of an inner tube, showed up differences between natural and artificial aging deterioration, reducing the significance of the data obtained. In the interpretation of the data, too much emphasis was placed on tensile and elongation degradation and not enough on modulus change.

The Vanderbilt researcher described changes in equipment design to overcome the deficiencies of the air oven. One of these, according to ASTM Specification D865, makes use of test tubes in which compounds are aged individually. This system controls air flow rate and eliminates contamination from volatile materials.

Another improvement was made on flexing test apparatus. Better simulation has been obtained by controlling the rate of flexing, temperature, and ozone concentration. Flexing tests, however, must be evaluated as a single component of the ultimate structure which is to be flexed.

Mr. Maassen concluded by cautioning that all accelerated testing conditions should simulate actual service conditions as closely as possible. Too drastic aging may be time wasted because results obtained may be misleading, he cautioned.

Dr. Beckman, currently president of the Los Angeles Chamber of Commerce, pointed out that Los Angeles is the third ranking industrial center in the United States and the second in volume of rubber goods manufactured. Estimating the rate of production increase in the area as twice that of the pre-World War II period, he asserted that the Los Angeles area will surpass Chicago in production volume, as well as in population, by 1961.

Nine door prizes were distributed at the meeting, all donated from the Tlargi prize fund. M. A. MacDonald, Pacific Hard Rubber Co., is chairman of the prize committee.

The Group's November 1 meeting, previously unreported, was held at the Hotel Statler and was addressed by Harold Gray, The B. F. Goodrich Co. Tire & Equipment Division, Akron, O., on the subject of "The Tubeless Tire—Past, Present, and Future." Speaking at the afternoon technical session was R. P. Wescott, Bakelite Co., New York, N. Y., whose talk dealt with elastomeric and non-rigid thermoplastic resins. Goodrich donated the 11 door prizes.

Best Rubber Division Paper by Copolymer Researchers

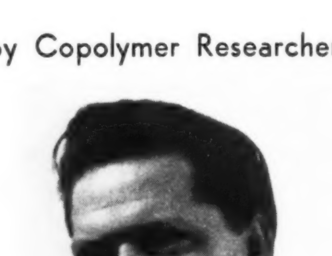
J. D. Sutherland and J. P. McKenzie, pilot-plant engineer and technical director, respectively, of Copolymer Rubber & Chemical Corp., Baton Rogue, La., have been selected as the authors of the best paper presented at the sixty-eighth meeting of the American Chemical Society's Division of Rubber Chemistry held in Philadelphia, Pa., November 2-4, 1955.

Entitled "A Glass Polymerization Vessel for Small-Scale Laboratory Studies," the paper described the development of such a glass polymerizer for the synthetic rubber industry which has both agitation and heat transfer characteristics superior to the commonly used bottle polymerizer.

The paper was selected by a committee of Rubber Division reviewers on the basis of the technical importance of the subject matter and the quality of the oral and visual presentations. This is the second award given for a Rubber Division paper; the first was won by J. S. Rugg and G. W. Scott, both of E. I. du Pont de Nemours & Co., Inc.

Mr. Sutherland first became associated with Copolymer in 1950 and has since served with the firm's mechanical engineering, process engineering, and research departments. He is currently assigned to the pilot plant where his duties include experimental polymer preparation, special research projects, and equipment design.

Dr. McKenzie served for nine years with Marbon Corp. before joining Copolymer in 1943 as a research chemist where he was active in the development of cold rubber. During the period of government ownership of the synthetic rubber plants, he represented Copolymer on several research and development committees in the synthetic rubber program. He was named technical director of Copolymer in 1946.



J. D. Sutherland

Petrochemicals in 1960

By 1960 the American petrochemical industry will probably have a capital investment of $8 billion, double its present value, Henry G. McGrath, associate manager of the business development department of M. W. Kellogg Co., New York, N. Y., told the first Delaware Valley regional meeting of the American Chemical Society, in Philadelphia, Pa., February 16.

Justifying his estimate, Mr. McGrath said the industry, now having $4-billion capital assets, has been doubling every five years and is now thought to comprise between 55 and 60% of the assets of the entire chemical industry.

Nearly 3,000 chemical substances are produced from natural gas and petroleum, and new products continue to come from these sources at the rate of 400 a year, he declared, adding that petrochemicals already account for almost 25% of total chemical production in this country.

Among the chemical products he listed as deriving from natural gas and petroleum are synthetic rubber, carbon black, ammonia, butadiene, ethylene glycol, the common alcohols, acrylonitrile, phenol, styrene, polyethylene, and formaldehyde.

AIEE Slates Conference on Rubber, Plastics Industries

A conference on electrical engineering problems in the rubber and plastics industries will be held at the Mayflower Hotel, Akron, O., April 9 and 10, under the sponsorship of the subcommittee on rubber and plastics of the American Institute of Electrical Engineers.

Among the scheduled speakers, and the subjects of their papers, are the following: P. G. Hanna, Westinghouse Electric Corp., **"Cypak, a New Concept in Industrial Control"**; Gregory DiCaudo, The Goodyear Tire & Rubber Co., **"Designing Safety into Electrical Controls"**; William Deans, I-T-E Circuit Breaker Co., **"Controlling Fault Currents in Low-Voltage Systems"**; J. L. Kuehlthau, Allis Chalmers, **"Silicone Rubber Motor Insulations."**

Also, Henry E. Mazanek, General Electric Co., **"Irradiated Polyethylene Motor Insulation"**; Henry L. Lee, Epoxylite Corp., **"Epoxy Resins for Motor Insulation"**; W. P. Curtis, Ford Motor Co., **"Pros and Cons of Standardization"**; A. G. Siefried, The B. F. Goodrich Co., **"Requirements of Regulators for Selected Applications"**; and W. H. Hickok, Girdler Corp., **"New Developments in Dielectric Heating."**

H. Warren, Roos, Wallace Clark & Co., will lead a panel discussion on **"Training of Personnel for Maintenance of Electrical and Electronic Equipment."** Moderator of a symposium on **"Problems of Equipment Operating in Contaminated Atmospheres"** will be E. L. Smith, The Firestone Tire & Rubber Co. W. S. Wolfe, Goodyear, will address the April 9 banquet.

Additional information on the two-day meeting may be obtained from R. S. Gardner, assistant secretary, American Institute of Electrical Engineers, 33 W. 39th St., New York 18, N. Y.

NEWS of the MONTH

Washington Report and National News Summary

. . . Congress approves sale of the Institute, W. Va., GR-S copolymer plant to Goodrich-Gulf Chemicals, Inc., for $11 million. One production line with annual capacity of 41,000 long tons of "hot" GR-S type rubber will be started soon, but the other two lines will be equipped for the production of "cold" rubber at a cost of $6 million and will not be available until 1958.

. . . It was revealed at the hearings in connection with the Institute plant sale that private producers of GR-S type rubber have sold small business consumers 144,731 long tons since May, 1955, a total "clearly in excess of commitments." Sales contracts with the buyers of these plants had committed them to 106,739 long tons per year.

. . . The University of Akron has decided "reluctantly and regretfully" to discontinue operation of the Government Laboratory at Akron, O., for the National Science Foundation, as of June 30, 1956. Offered a one-year lease with an option to buy this facility, the University said it simply did not have the money. Disposal by negotiated sale or mothballing the facility will be considered next.

. . . The rubber industry has indicated its support of the Boggs Federal Highway Bill now before Congress. The tax burden on tires of various sizes is considered to be in about the proper amounts and the highway program vital to the country.

. . . Effective in February the duty on tires and tubes imported into Cuba has been raised, and the duty on other rubber product imports lowered.

. . . The Commerce Department has predicted that capital expenditures will be about the same, production, sales, and employment in the rubber products industry somewhat less in 1956 than in 1955.

. . . The Natural Rubber Bureau has provided an estimated breakdown of the transportation segment of U. S. consumption percentage-wise in terms of total new rubber consumed.

Washington Report

Institute GR-S Plant Sale to Goodrich-Gulf Approved; Disposal of Louisville Butadiene Plant Slated Next

Congress turned its attention toward a long-term disposal plan for its last synthetic rubber plant—at Louisville, Ky.—after overwhelmingly okaying last month the sale of the GR-S copolymer plant at Institute, W. Va., to Goodrich-Gulf Chemicals, Inc.

Louisville Plant Disposal

The vote against two attempts to block the sale of the Institute plant was so heavy that observers consider new legislation to dispose of the alcohol butadiene plant at Louisville to be a shoo-in for favorable Congressional action.

Leading candidate for long-term operation of the Louisville plant under private auspices is Publicker Industries, Inc., Philadelphia, given the inside track because it now operates the plant under three-year lease and because it is considered the only company able to meet the competition of petroleum butadiene manufacturers, on a profitable basis.

While pending, the disposal bills on the Louisville facility call for sale under a procedure similar to disposal of the Institute plant—sold by the Rubber Disposal Commission for $11 million—the measures also provide for lease for 5-15 years.

Sources on Capitol Hill indicate that this language was no accident, that Publicker would prefer a long-term lease to outright sale. One reason for this attitude—the other 26 synthetic plants were sold—is believed to be the relatively high cost of producing butadiene from alcohol and the consequent risk of losing all or part of a large investment.

Publicker, with its own alcohol plant in Louisiana, is generally felt to be the only eligible firm which could make ends meet at the Louisville installation in the face of cheaper-to-produce petroleum butadiene. This plant, although on its face a tricky operation from the financial standpoint, has taken on a new attractiveness with the looming open-throttle operation at the Institute facility.

Institute Hearings

Witnesses at a Senate committee hearing on Institute plant disposal last month said that Institute's new owner, Goodrich-Gulf, would depend heavily upon the Louisville plant to supply a certain amount of butadiene. In fact, William I. Burt, president of Goodrich-Gulf, stated that a shortage of butadiene would force the company to keep two of its three production lines closed down until some time in 1958. Total capac-

ity of the Institute plant is 122,000 tons of GR-S type rubber annually.

Mr. Burt wheeled out some figures on produ tion at Institute in the face of a strong "monopoly" charge by Sen. J. William Fulbright, Arkansas Democrat, and Rep. Sidney J. Yates, Democrat from Illinois. These two Congressmen—plus Sen. Wayne Morse, Oregon Democrat—were the only legislators to question seriously the selling of Institute to Goodrich-Gulf.

To their charges that the sale would stifle competition in the production of synthetic rubber, Burt replied that it was "promotive of a truly competitive synthetic rubber industry" in terms of research, development, production, sales, and prices.

"The statement has been made," he told the Senate Banking and Currency Committee, headed by Fulbright, "that the sale of the Institute plant to Goodrich-Gulf will result in its having 25.2% of existing capacity. This would have been a true statement as of April 29, 1955.

"It is not, however, true today because since that time the capacity of a number of the plants has been increased, and any realistic consideration of the subject must also take into account announced expansions, which, when completed, will result in Goodrich-Gulf's having no more than about 18% of the existing capacity.

"Further, the figure of 18% assumes the operation of the full 122,000-ton capacity of the Institute plant. At present this is not realistic. In fact, butadiene, the principal raw material of synthetic rubber, is available, and until at least 1958 will be available, only in sufficient supply to operate one production line of this plant with a capacity of only 41,000 long tons.

"Prior to 1958, the Goodrich-Gulf share of total usable capacity will be no more than 140,000 tons a year—less than the announced planned capacities of two competitors and about equal to that of a third."

The company contends that it could hardly "exercise a dominant influence" with only 18% of existing capacity and when ultimate capacity will run at about the same levels of three other strong competitors.

In further support of its no-monopoly defense Goodrich-Gulf emphasized that, under the contract of sale, it is committed to sell reasonably equal monthly quantities of the Institute output to small business firms at fair market prices. The agreement calls for the following yearly tonnages to small businesses: (a) 21,000 long tons when only one line is in operation; (b) 51,000 long tons when two lines are in operation; and (c) 81,000 long tons when all three lines are in operation.

Mr. Burt disclosed that Goodrich-Gulf will spend $6 million to modernize the Institute plant and get it into full production. The company's chances of making it pay, he added, will not be good until butadiene production facilities at Port Neches, La., are put into production in about two years.

In the meantime Institute's output will be limited to 40,000 tons of "hot" rubber annually. The second and third production lines—to be devoted to "cold" rubber —will await completion of the Port Neches facilities and development of sufficient demand to warrant their operation.

Committee Comments

The majority report of the Senate Banking and Currency Committee in approving the Institute plant sale to Goodrich-Gulf included commendation of the synthetic rubber industry for the way "it has taken on the task of providing the vast quantities of rubber which American industry and the public have required.

"The success with which these companies have carried out their commitments to small business and their policy of refraining from increasing prices, in a time of shortages, are also to be commended," it was added.

The Senate group also praised the Attorney General for "keeping the committee fully informed about all aspects of competition or lack of competition in the synthetic rubber industry."

The House Armed Services Committee, in endorsing the Institute plant sale, also said:

"It is inconceivable to the committee that any purchaser of a copolymer facility would seek to renege on its contract to make rubber available to small business . . . and at the same time expect to continue to do business in this nation after having formally committed himself in public hearings to so supply small business."

Both committees pressed for information as to how much GR-S type rubber had been made available since the plants passed to private hands in May, 1955. Chairman Holman D. Pettibone, of the Rubber Producing Facilities Disposal Commission, testified that the buyers had committed themselves in their sales contracts to make available to small business 106,739 long tons of GR-S type rubber per year. He said he had canvassed producers just before the hearings and found on a pro-rata basis they had sold small business consumers 144,731 long tons, a total "clearly in excess of commitments."

Nevertheless it was also revealed at the hearings that the Justice Department has ordered the Federal Bureau of Investigation to keep track of the synthetic rubber producers' operations in connection with the amount of rubber provided small business organizations. The result of this investigation will be included in the annual report of the Justice Department on the synthetic rubber industry which is due on May 1.

NSF Government Laboratory One-Year Lease Proposal Rejected by University of Akron; Disposal Next

The Eisenhower Administration seemed certain to put up the Government Synthetic Rubber Evaluation Laboratories and Pilot Plant, of Akron, O., for sale this summer after the facility's long-time operator, Akron University, turned thumbs down on a one-year lease arrangement.

At a February 15 meeting of the institution's board of directors it was decided unanimously to make "the apparent, even though reluctant, choice" to discontinue operation of the facility, effective June 30, 1956. The synthetic rubber research center, operated by Akron University since 1944 on a cost-plus-fee basis for the government, was offered to the University rent-free for one year, beginning July 1, by the National Science Foundation.

Akron U Report

Taken under study by a five-member special committee headed by H. P. Shrank, vice president of Seiberling Rubber Co., the offer was rejected by this special group and then by the University directors for these two reasons:

"First, we do not have the funds to use as working capital to operate the business. Second, we cannot take the risk of losing money during the first year (and this is a highly probable result).

"We have talked with friends of the University who would help support the project financially the first year, but we cannot tell them how much financial help we would need to break even, and understandably, they are not interested in signing a blank check. Furthermore, we cannot answer their questions—'Where will the University get the money to buy the property at the end of the year's lease?' and 'How do you know you can operate without losses after you own it?'

"If we operate the first year under a lease and lose money, we probably won't want to buy it on future prospects. If we show successful operations, the bid price for the facilities will go up."

In giving notice that it will bow out in three months, Akron U said it was proud of its contribution to synthetic development and the success of the University-government arrangement of 13 years' duration.

Previous NSF Action

The Government Laboratories' function was not to conduct fundamental research for the 20-odd government-owned synthetic plants, but to make large factory-size batches of new rubbers (developed in research labs) for broad gage evaluation as possible end-products. The lab also developed processing techniques often not possible of achievement in research laboratories and impractical in rubber producing facilities, except at great cost and losses in output.

A year ago the government got out of the synthetic rubber producing business. All but one plant—at Lousiville, Ky.—have been sold to private companies. This decision, based on the lack of a rubber emergency and the free enterprise philosophy, was followed by an NSF recommendation that the government give up control of the Akron facility.

The recommendation suggested three possible courses of action: (1) disposal to Akron University; (2) negotiated sale to private interests; or (3) transfer to the National Bureau of Standards. The last choice, transfer to NBS, was dismissed by NSF immediately; the second, outright sale, was held to be "in no way adverse to the government or to the public interest"; the third, disposal to Akron University for one year, was the prime choice, provided no government money was to be spent.

Akron U Comments

The special Akron group which studied the offer of lease also considered three choices: (1) purchase after June 30, 1956; (2) one-year lease as offered; or (3) abandonment. Before reaching its decision to abandon, however, the group said it was reluctant to see University operation discontinued "for the following reasons:

"1. Even though the work of the laboratory is not classified as fundamental research, there is an opportunity to contribute to the advancement of knowledge, which is one of the functions of a university.

"2. The University would like to remain in a position of rendering service to industry, especially the rubber industry, with which it has long been associated.

"3. The University needs the $50,000 management fee it has received for operating the laboratory. This money has been used in our operations, and if it is lost, we will have to replace it from some other source."

The decision not to buy the facility was turned down by the institution for a very simple reason: It did not have the money. Extremely limited financially in its normal activities, the school felt it "ill-advised" to invest any capital in an operation which might benefit only a limited number of firms and which would be a risk venture in which the capital might be lost.

In effect, Akron University asked itself this question—What are the chances of the laboratory operating at a profit?—and came up with this answer:

"No one knows the answer to this question. Those close to the operation feel the profit prospects might be good. The laboratory needs a volume of business amounting to about $1,000,000 a year. The Federal Government is paying $950,000 for its operation during the fiscal year ending June 30, 1956.

"Upon the termination of this financial support, private contracts in this amount would have to be obtained in order to break even. A number of companies have shown an interest in entering into contracts, and some private work is now being done. But no true appraisal of the long-range possibilities is possible at this time. Under the circumstances, only short-range projects can be entered into because they must be completed by the end of June, 1956.

"Lacking definite knowledge, all we can do is speculate that the synthetic rubber and plastic businesses are large and growing in their activities, and these should be a good field for the Laboratory's work. On the other hand, companies now interested in the services of the Laboratory may build their own facilities to do this work, or they may withdraw from this outside service if they find it advisable to reduce their activities at some future date.

"Without government support or some other form of subsidy or guarantee, the future operation of the Laboratory is strictly a risk venture."

GSA to Sell

With the death-knell of Akron University management of the facility, NSF turned its attention to its second choice—negotiated sale to the highest bidder. The aim now is to get Congressional approval of this disposal plan in time to allow transfer to the highest bidder by July 1, the day Akron University turns the Laboratory back to the government.

It is likely that the General Services Administration, which manages the nation's stockpiles of rubber and other strategic, will be given the task of finding a buyer. If GSA is successful, the sale presumably will be subject to review by the Congress. If it is unsuccessful, the facility's future is anyone's guess.

Industry Supports Boggs Federal Highway Bill; Tax Burden on Tires Considered Well Balanced

The Rubber Manufacturers Association, Inc., led an almost unanimous private industry in support of the compromise legislation to give this country 40,000 miles of new and improved roads over the next 10 to 15 years.

In contrast to a year ago, when almost no industry faction would go along with the ill-fated proposal of Rep. George H. Fallon, (Dem., Md.), executive after executive moved into the Capital to throw his industry's weight behind the substitute bill (H. R. 9075) offered by Rep. Hale Boggs, (Dem., La.).

Perhaps RMA spokesman, Irving Eisbrouch, vice president of Dayton Rubber Co., spoke for non-government interests generally when he said:

"The tire manufacturing industry continues to believe very strongly that this country is in urgent need of the system of federal interstate and defense highways for which H. R. 9075 would provide needed revenue.

"At the last session of Congress we also expressed strongly our belief in the pressing nature of this need. We feel now, as we felt then, that this highway program is vital to the economic development and general well-being of all segments of our population as well as to the country's military defense."

AAR and NATRD Opposition

Aside from relatively light skirmishes, the only real battle to develop came when the American Association of Railroads, as expected, challenged the proposed assessments against the trucking industry as being too light. Rubber industry opposition was centered almost completely in the retreading field, where W. W. Marsh, executive secretary of the National Tire Dealers & Retreaders Association, attacked the 3¢-per-pound tax which has been proposed for "tread rubber."

Mr. Marsh complained that the tax would knock out a profit and even handling charges on 10% of a tire dealer's inventory investment, 7% of his accounts receivable, and 7% of his total sales.

"With such a burden, it becomes obvious," he said, "that the dealer has deep concern over his ability to carry his share of the highway taxes. Is it too much to ask that this burden not be made even heavier? The tire dealer asks that the proposed tax on tread rubber be eliminated!"

The federal-aid primary system consists of a total of about 234,400 miles, of which 16,500 miles are in the urban category, and 40,000 are included in the interstate system. The mileage of the secondary system is about 483,000 miles. The roads to be modernized are the 40,000 in the interstate system.

Commerce Comment

Secretary of Commerce Sinclair Weeks, in pointing up the drastic need of new roads, called the attention of Congress to the fact that two-thirds of the nation's highways are below minimum safe driving standards today—"much less tomorrow, with wornout pavements, poorly engineered curves, narrow rights-of-way, jammed intersections, and narrow bridges.

"Speaking in terms of national averages, the typical rural highway on the interstate system has a surface that was last improved in 1937, and a roadway on which the last major improvement of alinement and grade was made in 1932. Only about 5,000 miles of this system outside of towns have more than two lanes."

RMA Position

Eisbrouch, in his strong support for the Boggs bill, said it would bring "this great project" to reality on a practical basis, with fairness to all who use the roads and without imposing unjust burdens upon any group, "including the 300,000 tire dealers and retreaders of this country." He also gave Congress some very interesting figures on the practical effect of the legislation:

"The proposed additional tax of 3¢ a pound on new tires is an increase of 60% over the present tax, a larger proportionate increase than that proposed for any other commodity in the bill.

"The increased annual cost to the average passenger-car owner using the most popular size of tire and tube, the 6.70-15, would be about 75¢. The cost to him of the proposed new tax on tread rubber would be about 8¢ a year, making a total of 84¢ in additional or new taxes on rubber products used in passenger tires.

"As it applies to commercial vehicles, the proposed tire tax is fair. The impact on the very small trucks used largely by farmers and small merchants is relatively slight, as it should be. In the case of heavy commercial vehicles, including large trucks, tractor-trailer combinations, and buses, the greater tire weights and larger number of wheels naturally mean tax burdens that are relatively much greater.

"The increased annual cost to the average operator of a large 14-wheel, 4-axle, tractor-trailer combination, resulting from the proposed 60% increase in the excise tax rate on tires, would be about $34.50 a year. The cost to such an operator resulting from the proposed new tax on tread rubber would be about $9 a year, making a total of $43.50 in new rubber taxes.

"The increase of $43.50 a year which would be paid by the operator of the combination is 52 times the increased rubber tax of 84¢ that would be paid by the average passenger-car owner in a year."

GATT Negotiations Raise Cuban Tire and Tube Rates; Other Duties Lowered, But Branch Plants Benefit

The Cuban subsidiaries of two of this country's largest rubber manufacturers will be the chief beneficiaries of higher Cuban tariffs on tire and tubes which became effective in mid-February. Cuba's major tire and tube manufacturers are The Cuban Goodrich Co. (Compania Goodrich Cubana, S. A.) and Goodyear Tire & Rubber Co. of Cuba (Compania Goodyear de Cuba, S. A.).

GATT Deal

These two firms will reap the biggest rubber product benefits of the latest tariff negotiations between this country and our neighbor just off the tip of Florida. Tires and tubes were among 41 items imported into Cuba from this country covered by duty increases agreed to by the United States Department of State. In effect, Cuba produced proof that the boosts were necessary to protect its domestic manufacturers. In return for our agreement on these increases the U. S. was granted lower tariffs on 23 other items, including a 50% reduction in the duty on the natural or synthetic rubber belting used on sugar-making machinery.

The tariff adjustments came about when Cuba invoked a provision of the General Agreement on Tariffs and Trade (GAAT), a 35-nation pact covering international trade. Under the provision, Cuba called for new negotiations with the U. S. on earlier rubber concessions.

As explained by the State Department in announcing the new Cuban rates, the U. S. "took advantage of its right to negotiate" with Cuba with a view to obtaining new concessions equivalent to those lost—for example, on tires and tubes. U. S. participation in the renegotiations was guided by the recommendations of the Interdepartmental committee on Trade Agreements, which advised the President on trade agreement matters.

Other Firms Affected

While the higher tire and tube tariffs will be a boon to the two American firms with manufacturing affiliates in Cuba, they are virtually certain to hurt the more than half-dozen U. S. rubber firms with sales agencies in that country.

Among these, according to the U. S. tariff commission, are: Firestone Tire & Rubber Co., United States Rubber Co., The General Tire & Rubber Co., Kelly-Springfield Tire Co., Seiberling Rubber Co., Esso Standard Oil, Fisk Tire Division of U. S. Rubber, and Sears, Roebuck and Co. Through their Cuban sales representatives, chiefly in Havana, this group exported $3.5 million worth of tires and tubes to Cuba during 1953, the last year for which export figures are available. During the same year Cuban manufacturers reported an output of 84,538 passenger and truck tires and 39,786 passenger and truck tubes.

Cuban Tire Market

Exact size of the Cuban tire and tube market is rather elusive, since this major sugar-producing country has an economy heavily dependent on the year-to-year demand for this commodity. In a poor sugar year, both production and imports from the U. S. and other countries fall off drastically. In a good year, however, the Cubans generally go all-out to replace or modernize their commercial equipment, and they fall into the category of "good spenders" when it comes to pleasure vehicles.

The history of the Cuban tariff on tires and tubes presents an interesting picture. In 1927, following an economic disaster blamed on over-dependency on sugar, the Cubans took steps to diversify their economy and produce items for which there was a strong market at home. Until 1934, then, a high tariff—34¢ a kilogram (2.2 pounds)—was effective for tires and tubes, despite the complete lack of domestic producers.

The U. S. succeeded in getting a reduction to 24¢ in 1934 and a further concession to 18¢ in 1942. It was in the latter year that a Cuban tire industry was founded. Goodrich and Goodyear went into production of small tires during this war year, helped along by separate rationing allocations from their American counterparts.

Three years after peace came—in 1948—the Cuban tire makers had become a strong factor in the home market, and the tariff was increased to 25¢. Another boost—to 35¢—followed two years later, in 1950. Generally, that was the picture when the two countries opened the negotiations which led to last month's all-time tariff highs, the 1956 tariff. A key part of the new boost was the first minimum ad valorem duty ever imposed on imported tires and tubes. (An ad valorem tariff is a fixed percentage of a commodity's sale price as it leaves the exporting country's port of shipment.) As of mid-February, the tariff picture looked like this:

1. Tubeless tires (6-70 kilograms). Old rate—35¢ per kilo; new rate—50¢ per kilo, but not less than 30% ad valorem.
2. Tubeless tires (outside the 6-70 kilo range). Rate remains 25¢ per kilo, but a new ad valorem minimum of 15% is effective.
3. Conventional tires (6-70 kilos). Old rate—35¢ per kilo; new rate—50¢ per kilo, but not less than 30% ad valorem.
4. Conventional tires (outside the 6-70 kilo range). Rate remains 25¢ per kilo, but an ad valorem minimum of 15% is effective.
5. Bicycle tires. Rate remains 35¢ per kilo, but minimum ad valorem of 20% is effective.
6. Inner tubes (regardless of size and all types). Old rate—35¢; new rate—50¢, with an ad valorem minimum of 30%.

National News

Equipment Spending, Production, Sales in Rubber in '56 Will Approach '55 Figures—Commerce Department

The Business and Defense Services Administration of the U. S. Department of Commerce in the January issue of its monthly publication, "Chemical and Rubber-Industry Report," predicts capital equipment expenditures by the rubber products industry in 1956 will not exceed the 1955 rate of $149 million. Production about 6% less than in 1955, and sales somewhere between the $5,450 million figure of 1955 and the $5,097 million of 1953, were estimated. A moderate decline of employment in the industry and new rubber consumption of about 1,480,000 long tons in 1956 were seen.

As indicated above, it was estimated that the rubber products industry spent $149 million for new equipment in 1955, as compared with $131 million in 1954 and $161 million in 1953. The 1955 figure includes an estimate of $44 million for the fourth quarter, representing scheduled outlays by manufacturers for that period.

Capital outlays for the first quarter of 1956 are scheduled at $39 million, well above the actual expenditure of $30 million reached in the first quarter of 1955. With some reduction in the production of rubber goods probable in 1956 as a result of lower automobile output, capital outlays in the second half of the year may fall below the $39 million and $44 million for the third and fourth quarters of 1955, respectively. Capacity to produce has been raised substantially in recent years and for most rubber products appears reasonably ample to meet probable demands for the next few years.

In the first 10 months of 1955 the seasonally adjusted industrial production index for rubber products, as reported by the Federal Reserve Board, averaged 143, an increase of 24% above the 1954 average of 115 and 12% above the 1953 record of 128. For 1955 it is expected that the index will average about 144, an all-time high. The production index for the year 1956 is expected to be about 135.

Manufacturers' sales of rubber products are expected to exceed the 1953 peak of $5,097 million by more than $350 million in 1955. In this connection the price of

natural rubber should decline [and has] from the December 30, 1955, spot closing of 45½¢ a pound, but for the year 1956 may not average lower than in 1955. Output and volume sales of rubber products as a whole are expected to be below the 1955 level, and competition should be brisker, it was said. Prices of finished rubber goods, despite increased wage rates, may show some decline, especially in the case of tires. It appears now that total sales value in 1956 will not equal that of 1955, but may better the previous 1953 high.

In December, 1955, employment of production workers in the rubber products industry was 233,000, the highest figure ever recorded. The November total was 231,000. Employment in December, 1954, was 207,000. For the year 1955, employment averaged about 219,000, second only to the 220,000 averaged in 1947. Employment in 1956 is expected to show some decline.

Weekly earnings of rubber products workers in November, 1955, averaged \$91.37, up 10% over November, 1954, earnings. Average hours worked per week were 42.3 in November, 1955, against 41.1 in November, 1954. Hourly earnings for rubber products workers averaged \$2.16 in November, 1955, compared with \$2.02 in November, 1954.

Urethane Foam and Vinyl Flooring New RMA Interest

The Rubber Manufacturers Association is expanding the activities of its Mechanical Goods and Flooring divisions, respectively, to deal with technical and production problems involved in urethane foam and vinyl flooring.

Eight members of the RMA are now manufacturing urethane products, and a number of non-member manufacturers of urethane have indicated their interest in taking part in the activity. The work of this group will include formulation of minimum product standards, establishment of uniform testing methods, development of guides in establishing visible defects, and also the compilation of industry statistics.

Seven RMA members engaged in the production of rubber flooring are also now producing vinyl flooring, and there are several non-member manufacturers in the vinyl flooring field who have shown an interest in any new activity of the RMA in their field. This group will seek to develop specifications for vinyl flooring, work out recommendations on standard installation methods and approved maintenance methods, and provide for the collection and distribution of statistics on sales volume on an industry basis.

NRB Transportation Use Breakdown; Natural's Future

The Natural Rubber Bureau, Washington, D. C., in its monthly publication, "Natural Rubber News," for February provided an estimated breakdown of the transportation segment of United States consumption percentage-wise by product in terms of total new rubber consumed as follows:

Product	% Original Equipment	% Replacement and Export	% to Total Transport
Passenger and motorcycle tires	19.04	27.96	47.00
Truck and bus tires	8.42	24.52	32.94
Farm tires	2.04	1.60	3.64
Airplane tires	0.32	0.26	0.58
All motor vehicle tubes	1.06	2.66	3.72
Camelback			8.67
Industrial pneumatics			0.22
Solid tires and bogie wheels			0.51
Repair materials			0.87
Flaps			0.79
Curing bags			0.74
Bicycle tires and tubes			0.32
TOTAL			100.00

Approximate % transport to total consumption of all new rubber—63%.

Approximate % non-transport to total consumption of all new rubber—37%.

The NRB then went on to point out that the three largest-volume product uses for natural rubber in the U.S.A. in order of their importance are truck tires, passenger tires, and latex foam products. Manufacturers for the most part are pretty well committed to using natural rubber in truck tires because of its low internal heat build-up qualities, and natural rubber latex is still preferred to synthetic rubber latex for most volume uses, it was added. Consumption of natural rubber in passenger-car tires, however, depends upon price to a large extent and is therefore subject to wider usage variations except in that portion of tubeless tire construction which requires natural because of quality factors.

The NRB commented further that if the new synthetic natural rubber can be developed to approach natural's quality advantages in truck and bus tires *and* costs could be lowered from the 45-50¢-a-pound range, substitution would be possible, but this situation does not appear to be anywhere on the immediate horizon.

It was also the opinion of the Bureau that a substantial drop in the price of natural rubber to the level of GR-S type rubber would bring about some substitution of natural for synthetic in passenger-car tires, and if the lower levels prevailed for six months or more, passenger tires could replace truck and bus tires as the largest-volume user of natural rubber.

The average passenger-car tire now consumes 11⅓ pounds of new rubber per tire, while the average truck and/or bus tire consumes 39 pounds of new rubber per tire, the NRB said.

Other Industry News

Du Pont 25 Million-Pound Isocyanate Plant Activated

The new 25 million-pounds-a-year isocyanate plant of E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., has begun operations. The unit is located at the company's Deepwater Point, N. J., Chambers Works and currently employs more than 100 people.

The vigor of Du Pont's entry into the isocyanate field underlines the company's faith in the future of the material, a spokesman for the firm declared. Contrary to its chief American competitor in isocyanate production, Mobay Chemical Co., Du Pont will only make and market isocyanates, basic building block for the new polyurethanes. Similarly, it will not supply polyurethane fabricating equipment or technical assistance.

Isocyanates react readily with alkyd resins, alcohol, amines, water, or other materials to form rigid and flexible polyurethane foams. Although applications for these foams are so far relatively limited, intensive development work now going on is expected to reveal many more uses.[1] A 100,000-mile polyurethane rubber automobile tire has been widely discussed.

According to Du Pont, the foam has already found commercial application in dashboard and sun-visor crashpads on some new auto models, pillows and cushions, rug underlays, household sponges, insulating liners, shoulder pads for clothing, and other items.

Listed among the potential uses for the foam are prefabricated building panels with a foamed-in-place polyurethane core; cushioning for planes, trains, and buses; foamed-in-place insulation for home freezers and refrigerators; and foamed reinforcement for aircraft structures. These applications are now being field-tested, Du Pont says.

Development work is also being done on urethane rubber, said to be outstanding for its abrasion resistance. Other of its advantageous properties are high strength, toughness, good resistance to tearing, heat, and oxidation; and oil resistance. Du Pont urethane rubber, available in limited quantities, is known as "Adiprene." The isocyanate monomer has been designated "Hylene."

Alluding to the possibilities of law suits

[1] RUBBER WORLD, Mar., 1955, p. 765.

Night view of Du Pont's new Deepwater, N. J., isocyanates plant

challenging its right to use the isocyanate process, the company spokesman said that Du Pont had long-existing patents on the process, which evolved from the same research program that produced the material nylon.

Three recently published technical data booklets on isocyanates and urethane foams are being made available by the company's elastomers division. They are "Chemistry of Organic Isocyanates," HR-2; "Properties of Rigid and Semi-Rigid Urethane Foams," HR-1; and "Urethane Resilient Foams Made from Polyesters," HR-10.

Goodyear Institutes Broad Technical Education Program

Taking cognizance of the waning supply of technically trained men and women in this country, The Goodyear Tire & Rubber Co., Akron, O., has announced a comprehensive one-year educational program designed to stimulate interest and participation in scientific careers.

The program, believed by Goodyear to be the first of its type sponsored by a rubber company on such a broad basis, was devised by a committee of Goodyear officials working closely with representatives of public and parochial schools.

The plan has three major aims: providing for advanced technical training for full-time public and parochial high school mathematics and science teachers in Summit County, O.; increasing the enrollment and facilities of the Goodyear Apprentice School and the company-sponsored Engineering Squadron training program; and providing for financial aid to further the education of Goodyear personnel engaged in engineering and technical work.

The teacher phase of the program is open to all full-time high school mathematics and science teachers in Summit County. Sixteen will be selected for participation in the program during the 1956 summer vacation period. Two-thirds of those selected will receive scholarship awards covering cost of tuition in colleges or universities, plus laboratory fees and expenses. Mathematics, the physical sciences, or engineering may be studied.

The remaining eligible teachers will receive 10-week work-experience awards, joining the company payroll at one of its Akron plants at a salary rate equal to that of their teaching pay. Teachers will be selected from Akron and surrounding areas.

The second phase will consist of an increase in enrollment and facilities of Goodyear's Apprentice School and Engineering Squadron, with the firm paying the tuition of any fourth-year apprentice or Engineering Squadron trainee who will study engineering at the University of Akron or at any other college or university in northeastern Ohio. The time the trainee spends at the university must be outside of his regular employment.

In the final phase of the program, Goodyear will pay the tuition of any of its college-trained technical employes who wish to further their technical education by attending approved colleges and universities outside of their regular employment period.

At the end of a year of operation the program will be reviewed by the Goodyear committee to determine whether it should be continued and broadened.[1]

[1] RUBBER WORLD, Dec., 1955, pp. 393, 395.

American Biltrite To Buy Boston Woven Hose Firm

American Biltrite Rubber Co., Chelsea, Mass., will acquire control of Boston Woven Hose & Rubber Co., Cambridge, Mass., through the purchase of common stock, it has been revealed by John M. Bierer, president of the mechanical rubber goods manufacturing firm.

American Biltrite is reputed to be the largest producer of rubber goods for the shoe industry in the United States. It also owns and operates a flooring plant at Trenton, N. J.; a plastics plant at Stoughton, Mass.; a rubber goods plant at Sherbrooke, P.Q., Canada; and is a stockholder in the American Synthetic Rubber Corp., which purchased the Louisville, Ky., synthetic rubber plant from the government.

The combined sales volume of BWH and American Biltrite will make them the largest rubber goods manufacturer in the country, exclusive of the tire manufacturers, Mr. Bierer said. Management of Boston under Mr. Bierer as president and James N. Mason as executive vice president is expected to continue.

American Biltrite came into existence in 1908 at Trenton, N. J., as Panther Panco Rubber Co.

Witco Reorganizes Division

Witco Chemical Co., New York, N. Y., has reorganized its carbon black operations to put all laboratory facilities in one department. Designated the rubber chemicals technical service and control department, it will be headed by John H. Gifford, formerly in charge of the company's rubber chemicals laboratory in Akron.

Mr. Gifford will be responsible for all carbon black technical service, as well as for production control for Continental Carbon Co., a Witco associate. The new department will establish a direct line from Witco's carbon black chemists to its customers, the company says.

Harry M. Brubaker, vice president in charge of the carbon black and rubber chemicals division, of which the new department is a part, will continue as supervisor of overall sales and services. Leslie Carver and Daniel Chovan will handle the rubber technical service in the department, and Walter Tanner will continue with services for the ink, paint, and plastics industries.

Open Thermoid Warehouse

Thermoid Co., Trenton, N. J., has completed the building of a 20,000-square-foot warehouse adjoining its main plant. The new warehouse will help speed shipments of the company's industrial rubber goods to areas in the East, Thermoid says. This warehouse also has facilities for cutting hose and conveyor belts to lengths.

New company warehouses have also recently been opened in Atlanta, Ga., and Los Angeles, Calif., and plans are being made for the erection of another at Houston, Tex.

BFG Fuel Cells at L. A.

The B. F. Goodrich Co., Akron, O., has resumed the production of fuel cells at its Los Angeles, Calif., tire plant, according to C. B. McKeown, superintendent of the firm's aeronautical products manufacturing. Fuel cell production there was discontinued after World War II.

Manager of fuel cell operations is J. Terry Taylor. David L. Haines has been named technical manager of fuel cell design and engineering.

Fuel cells are flexible rubber fuel containers for military aircraft and other vehicles used by the Armed Forces.

Honor Nucleonics President

Wilbert E. Chope, 32-year-old president of Industrial Nucleonics Corp., Columbus, O., was presented with the Eta Kappa Nu Award for being "the outstanding young electrical engineer of 1955" at the mid-winter meeting of the American Institute of Electrical Engineers at the Statler Hotel, New York, N. Y., January 30.

The award of the electrical engineering honorary fraternity is given annually to an electrical engineer under 35, and out of college less than 10 years, in recognition of "outstanding technical accomplishments and meritorious service in the interests of his fellow men."

Mr. Chope helped found Industrial Nucleonics in 1950.

For the rubber industry, the firm makes equipment for the gaging and controlling of tire fabric calenders. More than half of its current business is done in process automation and control systems utilizing an isotope gage as the primary sensing element. The system, known as AccuRay Process Control System, is used in the metals, paper, plastics, tobacco, food, as well as rubber, industries.

Mr. Chope was graduated from Ohio State University in 1948 and holds a Master's Degree from Massachusetts Institute of Technology in business and engineering administration. He is chairman of the board of World Neighbors, Inc., a non-profit organization dedicated to the assistance of underdeveloped areas through the sharing of technical and agricultural knowledge.

Kellogg to Make Polyolefins

Pullman, Inc., parent company of M. W. Kellogg Co., New York, N. Y., has been licensed by Phillips Petroleum Co., to produce new types of polyolefin plastics through a process developed by the Bartlesville, Okla., firm, according to Champ Carry, Pullman president.

The Phillips process is said to be the first developed for converting ethylene mixed with other olefins into resin materials. The process, employing a new type of catalyst, yields an improved form of polyethylene, as well as assisting in the copolymerization of mixtures of olefins which is expected to result in many new resins.

Forms Molded Goods Firm

Controlled Rubber Products, Inc., newly organized manufacturing and custom engineering firm in the precision molded rubber field, has opened its plant at Willoughby, O., according to J. Warren Sackett, head of the company.

The firm will manufacture close-tolerance rubber molded products for the trade, with manufacturing for aircraft installation a major activity, Mr. Sackett reports. Controlled Rubber will also specialize in compound development, consulting work, and service engineering.

Mr. Sackett was formerly associated with B. F. Goodrich Chemical Co., in its development engineering department, and more recently with Thompson Products, where he was chief rubber engineer at one of its plants.

Rubber Reclaimers Elect

Chester H. Peterson, U. S. Rubber Reclaiming Co., Inc., Buffalo, N. Y., has been elected president of the Rubber Reclaimers Association, Inc., New York, N. Y. Also elected were Henry L. Dixon, The B. F. Goodrich Co., vice president; Charles T. Jansen, *Rubber Age*, secretary-treasurer; and Gilbert K. Trimble, Midwest Rubber Reclaiming Co., chairman of the executive committee.

Arkansas Roll Plant Opens

Sam'l Bingham's Son Mfg. Co., Chicago, Ill., has begun production at its new Searcy, Ark., industrial roll and printers' roller plant, according to the Arkansas Industrial Development Commission, which says that the company is the first northern firm "to capitulate to Arkansas' offer of up-to-date southern hospitality."

The avowed purpose of the recently organized Commission is to lure northern manufacturers "anxious to avoid the high taxes, labor problems, and traffic congestion of concentrated industrial areas" to underdeveloped Arkansas. Commission chairman is Winthrop Rockefeller, now a resident of the state.

The Searcy plant is the twenty-first of the Bingham company, the third of its roller facilities.

Pittsburgh Coke Appoints

Pittsburgh Coke & Chemical Co., Pittsburgh, Pa., has consolidated its coal chemicals and plasticizer divisions into its newly created industrial chemicals divison as another step toward expansion in the chemical field, according to W. K. Menke, vice president, chemical divisions.

The management of the new division will include Henry Avery, general manager; Duncan J. MacLennan, assistant general manager; and John L. Frothingham, sales manager. Alfred J. Oxenham will manage the division's product development group; while Homer W. Fry will serve as superintendent of production.

Sales assignments in the division will be as follows: Richard J. Murphy, New England; Harry W. Dudley, New York City; Edward H. Winkleman, New York State; Thomas H. Boyd, New Jersey; Walter H. Daub, Jr., Philadelphia; Raymond M. Wolber, Pittsburgh; Edison H. Shaw, Cleveland; James F. Hall, Jr., Chicago; and William F. Saunders, Los Angeles.

Lawrence N. Holden, Jr., and William R. Blackstock have been transferred from the field sales force to the staff of the product development group, based at the home office.

Heel, Sole Institute Elects

Forest Moor, Gro-Cord Rubber Co., and E. Colman Beebe, Beebe Rubber Co., have been elected president and vice president, respectively, of the Rubber Heel & Sole Institute. Other officers chosen were Robert A. Winters, Princeton University, secretary; M. J. Bernstein, American Biltrite Rubber Co., treasurer; and J. B. Reynolds, Hagerstown Rubber Co., director until 1959.

David W. Bernstein, American Biltrite, and I. B. Calvin, Bearfoot Sole Co., were elected president and vice president, respectively, of Elastic Colloid Research Corp., the Institute's research agency.[1] Others elected were W. P. Harty, Avon Sole Co., secretary; Mr. Moor, treasurer; Mr. Beebe, assistant treasurer; Dr. Winters, general manager and assistant secretary; and F. Moor and D. W. Bernstein, directors.

Elastic Colloid Research maintains a laboratory at Massachusetts Institute of Technology, Cambridge, Mass.

[1] India Rubber World, Dec., 1948, p. 367.

Publicity Division, Arkansas Publicity & Parks Commission

New Searcy, Ark., industrial roll plant of Sam'l Bingham's Son Mfg. Co.

Building New Cycolac Plant As Resin Use Seen Rising

What is termed a major expansion in the plastics manufacturing field has been undertaken by Borg-Warner Corp., Chicago, Ill., with the appropriation of $10 million for the building of a chemical plant on a 322-acre site at Washington, W. Va., which will produce a thermoplastic resin called Cycolac.

In making the announcement Roy C. Ingersoll, president of the firm, said that demand for the resin greatly exceeded the production capacity of the company's two plants at Gary, Ind.

Cycolac is a thermoplastic polymer containing acrylonitrile, butadiene, and styrene. It was developed and is being produced by Borg-Warner's Marbon Chemical Division.

Cycolac is described as having the toughness of rubber and approaching the surface hardness of most non-ferrous materials. Although primarily of interest to manufacturers of plastic goods, the material may eventually find application in the rubber industry as a substitute for hard rubber, as a reinforcing resin with rubber goods, and in other yet-to-be-determined functions.

It is currently being used to make such products as radio and television cabinets, hose nozzles, pipes and fittings, toys, and various automotive components. The company is convinced that uses not now filled by other plastic materials will be found for the new resin.

Advantageous properties of Cycolac include corrosion resistance, resistance to shatter, heat resistance, good electrical characteristics, and ease of processing and application. It has a specific gravity of 1.01 and is said to be surpassed on a strength-weight basis by only one material, nylon.

Big Tire Sales on Upswing, General Tire Man Declares

A great expansion in the big tire market has been forecast by L. A. McQueen, vice president of sales for The General Tire & Rubber Co., Akron, O. To meet the coming challenge, the tire executive said, his company has developed a dual-purpose, off-the-road giant tire and is currently engaged in a million-dollar expansion of its giant tire production facilities.

Declaring that the big tire market offers one of the greatest growth opportunities in the rubber industry, Mr. McQueen said that the steady and sizable industry-wide gains in giant tire sales over the past five years are "nothing in comparison with the potential of the decade ahead."

The company's new tire in this field was said to provide superior flotation, maneuverability, and tractive power, and was "fatter, tougher, and more adaptable to variations in terrain than its forebears." The width of the rim and tread has been increased by 12-15%.

Mr. McQueen said that the much-talked-about 40,000-mile Federal Highway Program would require a minimum of 75,000 trucks and work cars at the outset, in addition to thousands of pieces of road-building machinery. Most of this equipment would require giant tires.

"The aftermath of the nationwide highway undertaking will be just as pleasant, not only to the tire industry, but to the innumerable other segments of our economy," Mr. McQueen declared. "Passenger and truck tire production will be hard put to keep abreast of an insatiable demand for years to come."

Contributing to the company's decision to expand its big tire facilities were such factors as the many road and turnpike building projects on the drawing boards, other heavy construction involving earth moving, such as dams and hydroelectric installations; and the increased use of tire-equipped vehicles over crawler-type machines to be used for mining and logging work.

RTA Elects Young, Others

R. D. Young has been elected president of the Rubber Trade Association of New York, Inc., for the thirteenth consecutive year. Also chosen were F. J. Jackson, Hecht, Levis & Kahn, Inc., chairman; Herman Weinstein, Paul Elbogen & Co., Inc., vice chairman; Robert A. Badenhop, Robert Badenhop Corp., treasurer; Arthur J. Garry, secretary; and Joseph J. Dwyer, assistant treasurer.

According to RTA, the board of directors of the Association, in addition to Young, Jackson, Weinstein, and Badenhop, now consists of F. T. Koyle, Carl M. Loeb, Rhoades & Co.; Harold E. Poel, H. A. Astlett & Co., Inc.; S. J. Pike, S. J. Pike & Co., Inc.; S. E. Brennan, H. Muehlstein & Co., Inc.; W. B. Rothschild, M. Rothschild & Co., and Fred Thurkauf, Jacobus F. Frank Co.

The membership of the Association is made up of 29 dealer firms and 22 brokers and agents.

Dacron V-Belt Use Rising

Dacron-reinforced industrial V-belts are now being offered by most V-belt manufacturers, E. I. du Pont de Nemours & Co., Wilmington, Del., producer of the polyester fiber, reveals. Although these belts cost up to one-third more than standard belts of identical size and construction, they are capable of transmitting up to 40% more power and have a 50 to 250% greater longevity, according to du Pont.

The belts are now being used as original equipment on new industrial machinery and as replacements on drives where improved performance or lower maintenance are requirements, the chemical firm declares. The Dacron yarn used was developed specifically for the industrial market.

The superior performance of these belts is the result of such properties in Dacron as high strength, dimensional stability, flexibility, low moisture absorption, and resistance to abrasion, heat, oil, acids, and most alkaline materials, du Pont says.

"On existing drives, direct replacement with belts of Dacron polyester fiber can help with many troublesome drives, thus reducing downtime and maintenance costs," the company asserts. "On redesigned drives, belts of Dacron also permit use of smaller sheaves, thus lowering rebuilding costs and saving valuable equipment space."

RMA Vinyl Flooring Group

The Rubber Manufacturers Association, Inc., has expanded its activities to include manufacturers of vinyl floorings, according to R. R. Ormsby, president of the Association. The vinyl manufacturers' group will become part of the RMA flooring division.

For the present, however, the interest of the new group will be only in so-called homogeneous vinyl, which excludes those products referred to in the trade as felt-back vinyl, asbestos vinyl, and black-backed vinyl flooring.

The vinyl group will immediately attack such projects as the development of product specifications, recommended installation methods, and recommended maintenance methods, Mr. Ormsby said.

A meeting of the group's technical committee had been called for late February.

Represented at a January 26 meeting of the group at the Warwick Hotel, New York, N. Y., were American Biltrite Rubber Co., Trenton, N. J.; Danbury Rubber Co., Danbury, Conn.; The B. F. Goodrich Co., Watertown, Mass.; The Goodyear Tire & Rubber Co., Akron, O.; Hewitt-Robins, Inc., Fremont, O.; Kentile, Inc., Brooklyn, N. Y.; and Vinyl Plastics, Inc., Sheboygan, Wis.

OTS Publication Sales Up

American scientific organizations and industries last year purchased 64.8% more government research reports through the Office of Technical Services, United States Department of Commerce, Washington, D. C., than they did in 1954, according to John C. Green, OTS director.

This large increase in publication sales indicates increased awareness of these sources of technical information and their value in the nation's research and development programs, Mr. Green said. The value of the 1955 sales was almost $250,000.

The Office of Technical Services was specifically created to collect reports of government-sponsored research, reproduce them, and disseminate them to science and industry. The Army, Navy, Air Force, Atomic Energy Commission, and other agencies are sources of these reports.

The OTS announces their availability through press releases to the business and trade press and through its two monthly publications, "U. S. Government Research Reports," which abstracts about 300 reports each month, and "Technical Reports Newsletter." These subscription publications are handled by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Their cost is $6 and $1 a year, respectively.

Record Expansion for 1956 Scheduled for U. S. Rubber

United States Rubber Co., New York, N. Y., will spend $36 million in new plants and equipment during 1956, about $1 million more than the record high spent for such purposes in 1954, J. Chester Ray, administrative head of the company's tire division, told a gathering of business, government, and civic leaders at the Duquesne Club, Pittsburgh, Pa., February 2.

The luncheon-meeting followed groundbreaking ceremonies at the site of U.S. Rubber's proposed new branch and warehouse to be built in Stowe Township. The new facilities will replace present company warehouses at two downtown Pittsburgh locations. Completion is scheduled for the late fall.

The tire executive predicted that his company would record total sales in excess of $1 billion during 1956, the highest figure in its history. The rubber industry itself should sell $5¾ billion worth of goods during the year, he said.

James J. Kline, Pittsburgh branch operating manager for the company, said the new and larger quarters will provide improved distributing and warehousing facilities for tires, footwear, mechanical goods, electrical wire and cable, and hundreds of other products which are manufactured by U. S. Rubber.

The new branch will contain 110,600 square feet and will be located on a five-acre plot at the foot of McKees Rocks Bridge. The branch will serve western Pennsylvania, eastern Ohio, West Virginia, and western Maryland.

A. Schulman, Scrap Dealer, Now 40 Years in Industry

Alex Schulman, president of A. Schulman, Inc., Akron, O., scrap rubber and plastics dealer, is this month commemorating his fortieth year in the rubber industry, the company reveals.

Mr. Schulman became a salesman with The Goodyear Tire & Rubber Co. in 1916 and several years later transferred his interest to the scrap rubber field. In 1921 he was named manager of the Akron office of a scrap rubber firm and a director of the company. He resigned in 1928 to organize the firm that bears his name.

Reputedly one of the world's largest dealers in rubber and plastic scrap, A. Schulman also imports and deals in crude rubber, is a processor and dealer in hard rubber dust, and trades in rubber and plastic foam. The company has branch offices in East St. Louis, New York, and Boston, and two overseas subsidiaries, A. Schulman, Inc., Ltd., London, and A. Schulman (U.S.A.), Hanover.

The firm's Akron plant is located on a 20-acre site, where most of its scrap rubber operations, in addition to its foam regrinding, are carried out. Another plant, in Dorset, O., produces hard rubber dust. The company maintains a modern rubber laboratory in Akron.

Besides Mr. Schulman, the firm's executive board consists of James K. McElligot, vice president; William C. Zekan, vice president; Frank M. Francis, manager of the plastics division; Milton Kushkin, vice president and manager of the East St. Louis office; and Paul Baudry, vice president and manager of the New York office and of the export-import division.

© Fabian Bachrach

Alex Schulman

Landers Gives Record Sum To Firm's Retirement Plan

The largest amount ever contributed by the management of Landers Corp., Toledo, O., to its employes' profit-sharing retirement fund was paid for 1955, Robert G. Landers, president of the firm, has revealed.

The 1955 payment was equal to 15% of the total wages paid to all employes eligible to participate in the fund, the maximum allowed under the plan. This was the sixth consecutive year in which 15% was paid. The figure is six times greater than the first payment made when the plan was begun 14 years ago.

The coated fabrics manufacturer has contributed an average of 14.5% of wages to the fund since the end of the war and the termination of the excess profits tax, Mr. Landers said. Participating in the 1955 contribution were 133 employes, 79% of the firm's total employment. Workers begin profit-sharing after they have two years of continuous employment with the company.

The Landers plan is managed by a three-member retirement committee which acts as advisor both to participating employes and to the fund's trustee, the Ohio Citizens Trust Co., Toledo. Each committee member is a participant in the plan.

The employe's share of the profits is automatically deposited each year with the trustee who, with the approval of the retirement committee, makes investments for the fund. Participants share in the income of these investments. The entire amount in the employe's personal retirement account is made available to him when he reaches retirement age.

Ernest Spohn, president of Local 226, Textile Workers Union of America, CIO, lauded the plan for "giving us a real incentive for work, and building in all of us a true sense of working together."

Monsanto Adipic Acid Unit

Construction of a plant at Luling, La., for the large-scale production of adipic acid has been announced by Monsanto Chemical Co., St. Louis, Mo. To be completed early in 1957, the new unit will cost several million dollars.

Adipic acid has long been used in the manufacture of nylon. Its more recent application has been in the manufacture of flexible polyurethane foams for crash pads, seating, carpet underlay, and other cushioning uses.

Other uses of the reactive dibasic acid include the modification of surface coating resins, the imparting of flexibility to vinyls and polyesters, and in the manufacture of synthetic lubricants, detergents, and textile chemicals.

According to Charles H. Sommer, Monsanto vice president and general manager of the organic chemicals division, the new plant will be located on the site of the Barton plant of Lion Oil Co., a Monsanto division, and will be fully integrated with Lion raw materials facilities there.

Monsanto produces adipic acid elsewhere.

Kleinert Notions Breakfast

Ralph K. Guinzburg, president, and Richard Bleier, vice president, of I. B. Kleinert Rubber Co., New York, N. Y., addressed an estimated 1,000 merchandise managers and notions buyers at the firm's annual Notions Breakfast, held at the Hotel Sheraton-Astor, New York, N.Y., February 7. Leo Cherne, executive director of the Research Institute of America, and Gordon L. Mallonee, Miller & Rhoads, also spoke.

Name French Kel-F Agent

M. W. Kellogg Co., Jersey City, N. J., has appointed Saint-Gobain Co., of France, manufacturer of glass and industrial and agricultural chemicals, its exclusive agent in France and Spain for the sale of Kel-F fluorocarbon products.

With plants at St. Fons, Chauny, and Montlucon, the French firm also manufactures silicones in association with Dow Corning Corp. In the plastics field it makes monomeric vinyl chloride and vinyl polymers under its own process.

Quality Control Seen Aided by GE X-Ray/TV System

A nail protruding dangerously into the inside of a shoe is detected on the television screen of GE's new X-ray/TV system, illustrating the system's potentialities in the inspection of factory goods

An industrial inspection system incorporating the combined use of X-rays and television has been developed by General Electric Co., Schenectady, N. Y. Among the uses suggested for the system is the detection of faultily produced goods while being transported on a factory conveyor belt.

The X-ray/TV tieup is said to be more advantageous than the conventional fluoroscopic screen in producing an image many times brighter which can be viewed in daylight and at any point in the plant. The image can also be magnified to a size limited only by the TV viewing tube, while the reduced intensity of the X-rays cuts down hazardous exposure.

Although other image-brightening systems have been recently developed, GE says that its system "produces an image directly, by electronics, from the X-ray source, eliminating the complexities resulting from converting the X-ray image into a light image before intensifying it."

The image on the screen in the GE system can also be viewed simultaneously on other TV screens anywhere in a plant or on a screen some distance from the plant. A final virtue, according to the company, is that the signal created by the scanning beam can be recorded on magnetic tape and kept for a permanent record, or the image may be photographed from the viewing screen.

The GE system responds to X-rays generated at voltages as high as 1,000,000, therefore making possible the remote visual inspection of such highly dense products as steel.

"This will prove of great value in those industries where speed of examination and lower inspection costs are paramount, and it is not essential to make a permanent record on X-ray film," the company declares.

Describing the mechanics of the system, GE says that the X-ray beam first passes through the object being examined, striking a photo-conductive layer of lead-oxide placed on the inside of a special 8½-inch-diameter TV pick-up tube. A low-speed 250-volt electron beam then reads the latent image on the lead-oxide layer by scanning it, presenting the image, electronically amplified, on a TV viewing tube similar to those in conventional TV receivers.

Credited with developing the system are John E. Jacobs, manager of the advanced development laboratory in GE's X-ray department at Milwaukee, Wis., and his associate, Harold Berger.

Hobbs' "Engineered Winding"

What is called the first available complete installation service in connection with the winding of webs or sheets of all types, including extruded plastics, has been announced by Hobbs Mfg. Co., Worcester, Mass. Dubbed "engineered winding," the service involves the custom design of complete winding installations which are specially engineered for specific requirements.

Heretofore plants that do winding have had to purchase various winder elements from different sources, or to build certain elements themselves, the company says. In addition to analyzing winding problems and designing equipment to solve them, Hobbs will assist in setting up the installations and getting them into operation.

Heart of the newly available service is the Hobbs-Alquist Winder which supplies ample power, independently of the main drive, with a squirrel cage, three-phase AC motor flange-mounted to a gear reducer. According to Hobbs, the device assures constant winding tension, automatically controlled by presetting a dial, and enables a build-up as great as 10 to 1, with elimination of stretching and distorting.

Tests Inflatable Monoplane

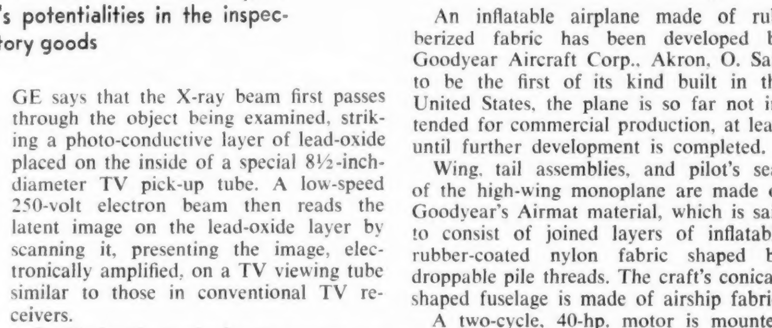
An inflatable airplane made of rubberized fabric has been developed by Goodyear Aircraft Corp., Akron, O. Said to be the first of its kind built in the United States, the plane is so far not intended for commercial production, at least until further development is completed.

Wing, tail assemblies, and pilot's seat of the high-wing monoplane are made of Goodyear's Airmat material, which is said to consist of joined layers of inflatable rubber-coated nylon fabric shaped by droppable pile threads. The craft's conical-shaped fuselage is made of airship fabric.

A two-cycle, 40-hp. motor is mounted on a tubular support above the fuselage directly behind the wing. Metal supports connect the wheels and pilot's seat with the fuselage. High-strength, fan-shaped patches of rubberized material are used to attach the various members, struts, and other supports.

Less air pressure than that required to inflate passenger-car tires is needed to pump up the plane, the company says.

The plane was developed to test the possibilities of Airmat as structural material for aircraft.



Goodyear's experimental inflatable airplane

News about People

J. W. Smith has been advanced to eastern sales manager for the industrial products division of The Goodyear Tire & Rubber Co., Akron, O., replacing **O. A. Schilling,** who was promoted to manager of industrial products departments of the division. **J. L. Sinclair** has been transferred to manager of the division's Chicago sales district and has been succeeded as Cleveland district manager by **R. J. Ario,** previously Charlotte district manager.

John W. Roy has been transferred to the mechanical goods division of United States Rubber Co., New York, N. Y., with headquarters at Baltimore, Md., and will be succeeded in the Washington, D. C., government department of the company by **Joseph W. Devorss, Jr.,** formerly at the Boston branch of the company.

Kurt Frisch has been named manager of polymer research at Wyandotte Chemicals Corp., Wyandotte, Mich. Dr. Frisch was formerly with E. F. Houghton & Co. and the chemicals division of General Electric Co.

John F. Snyder, Jr., has been appointed works manager at the Kenton, O., plant of the Durez Plastics Division of Hooker Electrochemical Co., Niagara Falls, N. Y.

Malcolm R. Buffington has been elected vice president and technical director of Lea Fabrics, Inc., Newark, N. J.

H. E. Klein and **G. A. Trigaux** have been advanced to product managers in the fine chemicals department of Carbide & Carbon Chemicals Co., division of Union Carbide & Carbon Corp., New York, N. Y. They will be responsible for market development of resin chemicals and Oxo process chemicals, respectively.

David Healy, sales representative for Taylor, Stiles & Co., Riegelsville, N. J., will now cover the New York, N. Y., and Long Island areas in addition to his New York State and parts of New Jersey assignment.

Charles A. Heiberger, research director of the Ohio-Apex Division of Food Machinery & Chemical Corp., Nitro, W. Va., has been named manager of the plastics and polymers department of the FMC chemicals central research laboratory at Princeton, N. J. Succeeding Dr. Heiberger as research director is **Paul E. Williard,** formerly assistant research director.

John A. Wilson has been elected assistant secretary of Diamond Alkali Co., Cleveland, O.

W. Wallace Roff, executive vice president and director of Whittaker, Clark & Daniels, Inc., New York, N. Y., has been appointed director of Canada Talc Industries, Ltd., Toronto, Ont., Canada.

W. Wallace Roff

R. C. Seanor has been promoted to vice president in charge of engineering for Adamson United Co., Akron, O. Since 1950 he has been in charge of engineering at the Akron plant. He joined Adamson in 1946.

Charles Mayer Studios

R. C. Seanor

Fred P. Demme has been promoted to manager of market development for the Sharples Chemical Division of Pennsylvania Salt Mfg. Co., Philadelphia, Pa.

Joseph J. Wadlinger, formerly of the engineering training squadron at The Goodyear Tire & Rubber Co., Akron, O., is now with the process engineering section of the firm's research division.

Dale E. Mancuso has joined the research and development department staff at the Glendale Plaskon Laboratory of Barrett Division, Allied Chemical & Dye Corp., Toledo, O.

Emil R. Albert, Jr., has been appointed president and general manager of Rubarite, Inc., Chicago, Ill., succeeding **Harold B. Pullar,** who will remain with the company as an officer and director.

Pitt B. Harris has been named general sales manager of the foam products division of Hewitt-Robins, Inc., Stamford, Conn., succeeding **R. B. Hamilton,** who has resigned.

Richard Firstenberg has joined First Machinery Corp., Brooklyn, N. Y., as sales manager of its Falcon Mfg. Division.

John A. Bowler and **Noel S. Siegel** have been named field engineering representatives in the New York, N. Y., and Chicago offices, respectively, of Lord Mfg. Co., Erie, Pa.

Thomas E. Wallis has been appointed assistant to the general manager of Stokes Molded Products Division of Electric Storage Battery Co., Trenton, N. J.

Raymond J. Love has been advanced to factory manager of Pequanoc Rubber Co., Butler, N. J. He started with the company in 1948 as an industrial engineer.

Chell Frantzen Studios

Raymond J. Love

R. G. Kelso

Sherman Stambaugh has joined Celanese Corp. of America, New York, N. Y., as director of publicity and press relations.

John J. Egan has been advanced to manager of the Washington, D. C., office of International B. F. Goodrich Co., Akron, O.

A. I. Goldberg and **O. B. Wurzburg, Jr.,** have been advanced to associate directors of research for National Starch Products, New York, N. Y. **Fred Eastman** has been promoted to superintendent of process development for the company.

John J. Sly has been named manager of the central region of The Dayton Rubber Co.'s industrial wholesaler division, Dayton, O.

Francis W. Kayser has been appointed sales manager in the New England area for Hewitt-Robins, Inc., Stamford, Conn., succeeding **A. A. Beaulieu,** who has retired.

Glenn M. Sweitzer has been advanced to manager of the Chicago district sales office of Seiberling Rubber Co., Akron, O., succeeding **Anton F. Kross,** who has resigned.

W. W. Schneider, vice president, treasurer, and general counsel of Monsanto Chemical Co., St. Louis, Mo., has been elected to the company's executive committee, succeeding Executive Vice President **R. R. Cole,** who has retired after 40 years of service. Mr. Schneider joined Monsanto in 1921 as an assistant in the law department.

C. K. Ballard has become Houston district sales manager for Columbia-Southern Chemical Corp., Pittsburgh, Pa.

Ross E. Wilson has been elected vice president of Firestone Plantations Co., Liberia, continuing as general manager there.

R. G. Kelso and **Richard H. Proctor** have joined the sales staff of the chemical division of Emery Industries, Inc., Cincinnati, O.

Joseph V. Borland, associated with Watson-Standard Co., Pittsburgh, Pa., since 1934, has been appointed a vice president.

Joseph V. Borland

Norman E. Hathaway has been appointed coordinator of marketing for Oronite Chemical Co., San Francisco, Calif., a subsidiary of Standard Oil. Co. of California. He was formerly general sales manager of industrial chemicals for Davision Chemical Co. and has served as director of the Chemical Rubber Division, Business & Defense Services Administration, United States Department of Commerce.

Fred R. Abel has been named assistant controller in charge of accounting for the conveyors and engineers divisions of Hewitt-Robins, Inc., Stamford, Conn., and is succeeded as Passaic, N. J., plant controller by **Walter G. Neeb.** Also appointed were **E. Pennington Meyer,** to assistant controller of accounting for the foam products division; **Randolph L. Hickey,** to Buffalo foam plant controller; **Edwin G. Shuttleworth,** to assistant controller of rubber division accounting and industrial products sales expense accounting; and **Ralph S. Crosman,** engineers division controller, to additional duties on contract matters.

Samuel H. Ashworth has joined the physics and electronics section of The Goodyear Tire & Rubber Co., Akron, O.

H. E. Markley and **George L. Deal** have been named assistant to the president and secretary-treasurer, respectively, of The Timken Roller Bearing Co., Canton, O.

Richard T. DeLoe has been named general manager of Malayan American Plantations, Ltd., subsidiary of United States Rubber Co., New York, N. Y. He joined the parent company in 1937.

Richard H. Proctor

Elden H. Eaton has been elected assistant treasurer of The Firestone Tire & Rubber Co., Akron, O. He joined the company in 1926.

Harper V. Bressler, assistant sales manager of the industrial products division of The Goodyear Tire & Rubber Co., Akron, O., has retired after a 37-year association with the company.

Walter J. Dugan has been advanced to manager of sales development in the marketing section of the silicone products department of General Electric Co., Schenectady, N. Y.

Bruce E. Esterly, controller of Cooper Tire & Rubber Co., Findlay, O., has been elected to membership in the Controllers Institute of America.

John L. Patterson has been named manager of the sales promotion department of the plastics division, Celanese Corp. of America, New York, N. Y.

Edwin H. Schwarze has joined Witco Chemical Co., New York, N. Y., as technical service representative of the Pioneer Products Division.

Lawrence D. Bragg, Jr., has been advanced to the office of assistant general manager of the Respro Division, The General Tire & Rubber Co., Cranston, R. I.

Gordon Parks has been named field representative in the Rocky Mountain area for Republic Rubber Division of Lee Rubber & Tire Corp., Youngstown, O.

J. Guyton Boston, general sales manager of the textile division of Celanese Corp. of America, New York, N. Y., has been named assistant director of marketing for the division and will be succeeded by **W. D. Clark** as general sales manager.

R. B. Warren

W. T. Meinert

N. A. Ruston, director of development and service for Emery Industries, Inc., Cincinnati, O., has retired after 26 years of service with the company. He has been succeeded by **W. T. Meinert,** formerly assistant director of the department, who joined Emery in 1949.

William J. Moore has been named technical sales and service representative in the San Francisco and Pacific Northwest areas for Wharton Jackson Co., San Marino, Calif., distributor of various talc and clay products.

Robert R. Johnson has been named chief engineer for Minnesota Rubber & Gasket Co., Minneapolis, Minn. He was formerly general manager of a company subsidiary, Master Tools, Inc.

A. K. Doolittle has been appointed senior scientist in the research department of Carbide & Carbon Chemicals Co., division of Union Carbide & Carbon Corp., New York, N. Y. He will direct a basic research program in liquid-state physics.

R. B. Warren, manager of the industrial products departments of The Goodyear Tire & Rubber Co., Akron, O., has been named sales manager of The Goodyear Tire & Rubber Co.'s industrial products division, succeeding **H. D. Foster,** who will retire on May 31 after 43 years of service with Goodyear. **O. A. Schilling,** formerly eastern sales manager of the division, has replaced Mr. Warren.

E. H. Strobel, manager of passenger and heavy-duty tire inspection at the Des Moines, Iowa, plant of The Firestone Tire & Rubber Co., Akron, O., has been advanced to production manager there. He was formerly plant manager of the company's tire plant in Buenos Aires, Argentina.

L. J. Polite, Jr., agricultural chemicals sales manager of the chlorinated products division of Diamond Alkali Co., Cleveland, O., has been advanced to product sales manager for a diversified group of organic chemicals. He succeeds **W. B. Beeson, Jr.,** now manager of the New York, N. Y., branch office. Assuming Mr. Polite's position is **John W. Kennady,** formerly general manager of Diamond Black Leaf Co., a Diamond affiliate.

William G. West has been appointed head of the copolymer and homopolymer polyvinyl acetate emulsions department, plastics division, of Celanese Corp. of America, New York, N. Y.

Nicodemus E. Boyer has joined the research and development department of Hooker Electrochemical Co., Niagara Falls, N. Y., and will do organic research.

Martin J. Tierney

Martin J. Tierney, assistant commercial development manager of Naugatuck Chemical Division of United States Rubber Co., Naugatuck, Conn., has been named commercial development manager. He succeeds **Clayton Ruebensaal,** now director of commercial planning for Texas-U.S. Chemical Co.

E. H. Strobel

Ivan Thomas

Ivan Thomas has been appointed production superintendent, and **Ralph L. Quinlan** has been promoted to assistant development manager of the Windsor, Vt., shoe products plant of The Goodyear Tire & Rubber Co., Akron, O.

Joseph E. Powers, sales manager of the truck and bus tire department of the B. F. Goodrich Co. Tire & Equipment Division, Akron, O., has retired after 45 years of service with the company. He has been succeeded by **William H. Campbell,** Pittsburgh district manager of replacement sales in the Division.

Harlan M. Tramwell has been appointed director of rayon operations in the manufacturing department of the Charlotte, N. C., textile division of Celanese Corp. of America, New York, N. Y.

Byron H. Larabee has been elected assistant secretary of The Firestone Tire & Rubber Co., Akron, O., and president of Firestone Plantations Co. He has been associated with Firestone since 1939.

Harold D. Orloff has joined the diene synthetic rubber section of the research division of The Goodyear Tire & Rubber Co., Akron, O.

R. P. Wilson has been appointed special assistant to the general sales manager of the textile division of Celanese Corp. of America, New York, N. Y.

Sam Emison has been appointed director of industrial chemical sales for Stauffer Chemical Co., New York, N. Y., replacing **R. U. Haslanger**, who has resigned.

Richard E. Chaddock has been named director of development for the Virginia cellulose department of Hercules Powder Co., Wilmington, Del., and has been succeeded as manager of the company's sales research division by **William G. Kinsinger**, formerly sales manager of the oxychemicals division of the naval stores department.

Ernie Munkacsy has joined Ferro Corp., Cleveland, O., as sales engineer in the Ohio area for the company's color division.

Merrill M. Smith, chief chemist for American Biltrite Rubber Co., Inc., Trenton, N. J., has been advanced to plant manager. He joined American Biltrite in 1952.

David W. Knowles and **John H. Peden** have been elected vice president in charge of sales and assistant treasurer and clerk, respectively, of Globe Rubber Works, Inc., Boston, Mass. Mr. Peden succeeds **I. Leah Crandall**, who has retired after a 50-year association with the firm.

F. S. Rostler, director of research for Golden Bear Oil Co., Los Angeles, Calif., has been elected an associate of the Institution of the Rubber Industry, London, England.

W. L. Davidson, Hugo Stange, and **S. C. Carniglia** have been appointed assistant director, organic chemistry department manager, and inorganic and physical chemistry department manager, respectively, of the Princeton, N. J., Central Research Laboratory of Food Machinery & Chemical Corp., chemical divisions, New York, N. Y.

David W., Eliot L., and **Maurice J. Bernstein**, American Biltrite Rubber Co., Chelsea, Mass., have been elected to the board of directors of Boston Woven Hose & Rubber Co., Boston, Mass. Other American Biltrite executive officers elected to the board are **Aaron J. Bronstein** and **Miah, Richard J.**, and **Robert G. Marcus**.

Stauffer Chemical Co., New York, N. Y., has changed the name of its Vernon, Calif., Western-Pacific Container Division to Molded Products Division.

News Briefs

Celanese Corp. of America, New York, N. Y., is developing new transportation and decorative fabrics from its fire-retardant acetate filament yarn.

Carbide & Carbon Chemicals Co., New York, N. Y., is raising the capacity of its Seadrift, Tex., ethylene oxide plant to more than 200 million pounds a year, resulting in a 65-million-pound increase of its commercially valuable ethylene glycols. Ethylene oxide is also a source of acrylonitrile.

Witco-Continental Chemical Co., New York, N. Y., will start production at its new Eunice, N. M., SRF carbon black plant in May. An estimated 25 million pounds of semi-reinforcing furnace black will be made annually. The material is said to be in current short supply.

M. W. Kellogg Co., New York, N. Y., about April 29 will move its main offices from 225 Broadway to 711 Third Ave., where its parent company, Pullman, Inc., also will go.

The Goodyear Tire & Rubber Co., aviation products division, Akron, O., is producing the wheels, brakes, and rotor brake for the world's largest helicopter, the U. S. Air Force's XH-17 heavy-duty cargo transport which can carry loads of more than 10 tons, including tanks, howitzers, and bridge sections.

General Electric Co., silicone products department, Waterford, N. Y., will package all of its silicone products in green and white lithographed drums, designed to make recognition easier in crowded warehouses.

Johns-Manville Corp., New York, N. Y., has signed an option on a large gypsum deposit in southern Nevada and is considering entering the gypsum business.

The Dayton Rubber Co., Dayton, O., has increased the authorized number of shares of its common stock from 900,000 to 2,000,000.

Hammel-Dahl Co., Providence, R. I., has appointed E. B. Miller Co., St. Louis, Mo., as sales representative in the St. Louis area for its automatic control equipment.

Carbide & Carbon Chemicals Co., division of Union Carbide & Carbon Corp., New York, N. Y., is making available in tank-car quantities its propionaldehyde produced at its new Texas City, Tex., Oxo unit. Propionaldehyde is used to make propylamines, valuable as rubber accelerators, and reacts with formaldehyde to yield trimethyl ethane, a polyol intermediate for alkyd resins and in polyester resins for polyurethanes.

Monsanto Chemical Co., St. Louis, Mo., has announced plans to expand its Everett, Mass., phthalic anhydride production facilities to provide a 60% increase in the plant's output.

Wellco-Ro-Search, Waynesville, N. C., will double the capacity of its machine-building factory by the addition of new working space and facilities.

American Maintenance Supply Co., Chicago, Ill., has changed its name to Arrow Laboratories, Inc. The firm makes Detero Wax Beads, which are used in rubber compounding.

Quaker Rubber Division, H. K. Porter Co., Inc., Philadelphia, Pa., has developed an air hose for the purpose of keeping jet engines heated and ready for immediate use. The hose, "constructed entirely of synthetic materials," can handle air continuously at temperatures ranging up to 400° F. and working pressures going up to 100 psi.

Surety Rubber Co., Carrollton, O., has introduced red neoprene industrial gloves which are said to be more visible under plant conditions than the conventional black gloves, which property constitutes an added safety factor.

Phillips Petroleum Co., Bartlesville, Okla., has licensed the Societe des Usines Chemiques Rhone-Poulenc of France to use its new process for making rigid polyethylene.

Celanese Corp. of America, New York, N. Y., has begun construction of its new process development laboratory at Charlotte, N. C., which will have 30,000 square feet of floor space.

Automotive Rubber Co., Inc., Detroit, Mich., has made available a folder containing 11 samples of rubber and plastic lining compounds. The specimens, compounded, milled, and calendered by ARco, are said to represent standard compounds used in the majority of corrosion and abrasion-resistant lining work on tanks, vessels, pipe, fittings, ducts, fans, and other equipment.

Obituaries

pilation of Volume I of "Machinery and Equipment for Rubber and Plastics," published by RUBBER WORLD in 1952, and until his death served in the same capacity for the forthcoming volume.

He leaves his wife, a son, two grandchildren, his mother, and a brother.

A Requiem Mass for Mr. Flannery was offered January 31 in Akron's St. Sebastian Church.

George Oenslager

George Oenslager, former chief chemist of The B. F. Goodrich Co., Akron, O., and one of the industry's most noted researchers, died of a heart attack aboard the Italian liner *Conte Biancamano*, February 5. Dr. Oenslager was sailing for Europe with his wife.

Dr. Oenslager's research has been widely credited with having brought about the reduced prices and increased longevity of tires and other vulcanized products. He developed the first nitrogenous organic accelerators and was instrumental in the introduction of carbon black as a rubber reinforcing agent.

In 1933 he received the Perkin Medal of the Society of Chemical Industry as "the American scientist who has most distinguished himself by his services in applied chemistry," and whose revolutionary achievements in the rubber industry have resulted in great manufacturing economies, increases in service, and savings to consumers that run into hundreds of millions of dollars annually.

In 1948, Dr. Oenslager was awarded the Charles Goodyear Medal of the Division of Rubber Chemistry of the ACS for his work in rubber chemistry.

He was born in Harrisburg, Pa., on September 25, 1873. Dr. Oenslager was educated at Harvard University where he received an A.B. degree in 1894 and an A.M. degree a year later. At Harvard he served as an assistant to the late Prof. T. W. Richards, 1914 Nobel Prize winner in chemistry. Previously Oenslager had worked with Thomas A. Edison on the possible use of rubber in phonograph records.

He began his professional career as a research chemist with S. D. Warren & Co., a paper manufacturing firm, serving from 1896 to 1906. He then joined Diamond Rubber Co. and became associated with Goodrich when that company absorbed Diamond six years later. He remained with Goodrich until 1942, except for a brief period as technical adviser to Yokohama Rubber Co., in Japan, 1920-22.

From his retirement in 1942 until his death, Dr. Oenslager maintained his own research laboratory in Akron.

An ardent traveler, he had many interests outside the rubber field. He was a past chairman of the Akron Section of the American Archeological Society, a former trustee and past president of the Akron YMCA, an erstwhile director of the Art Institute, a past president of the University Club, and a vestryman of St. Paul's Episcopal Church.

He is survived by his wife, his brother, and a nephew.

Funeral services were held February 16 in St. Paul's Episcopal Church. Burial was in Akron's Glendale Cemetery.

George Oenslager

H. A. Flannery

H. A. Flannery

Harold A. Flannery, manager of engineering for The Goodyear Tire & Rubber Co., Akron, O., since 1935, died January 28 following a heart attack sustained four days previously. He was 62.

During the later stage of his 39-year association with the company, Mr. Flannery was responsible for planning and supervising of construction of manufacturing plants and other properties of the worldwide Goodyear organization. He had been working on the company's current $114-million expansion program at the time of his death.

He was born at Horseheads, N. Y., on April 3, 1894.

Mr. Flannery was educated at Cornell University and joined Goodyear in 1917 as an assistant in the tire design development department. He became division superintendent of the company's Plant Two, Akron, in 1927, and the following year was appointed general superintendent of Goodyear's Wolverhampton, England, plant. He returned to Akron in 1935 as manager of engineering.

He subsequently directed engineering construction and equipment planning in the building of new rubber fabricating plants at Jackson, Mich., Topeka, Kan., Lincoln, Neb., and St. Marys, O.; synthetic rubber plants in Akron, Houston and Baytown, Tex., and in Los Angeles, Calif.; and foreign plants in Brazil, Sweden, Mexico, Peru, Union of South Africa, Cuba, Colombia, Venezuela, Canada, and Luxembourg.

Mr. Flannery was on the editorial advisory board which assisted in the com-

Ernst A. Hauser

Ernst A. Hauser, an internationally known authority on colloid chemistry, died suddenly at his Cambridge, Mass., home on February 10. He was a professor of chemical engineering at the Massachusetts Institute of Technology, Cambridge, and had been a resident member of the faculty since 1935.

Dr. Hauser received his doctorate at the University of Vienna and was awarded an honorary doctorate in science by Worcester Polytechnic Institute. He began his career as an assistant at the University of Goettingen, Germany, and later joined the colloid laboratories of Metallgesellschaft, Germany, where he became chief chemist. From 1932 to 1935 he was chief chemist of Austro-American Rubber Works, Vienna, Austria. He was named a full professor at MIT in 1948. During World War II he served as consultant to the Office of the Quartermaster General and as technical adviser to the Baruch synthetic rubber committee.

Dr. Hauser became a naturalized United States citizen in 1941 after having come to this country in 1935.

He was the author of many books and papers on colloids and allied chemical fields. He was a fellow of the American Association for the Advancement of Science, American Institute of Chemists, Institution of the Rubber Industry (London), and the New York Academy of Sciences and was also a member of the American Chemical Society, National Research Council, American Institute of Chemical Engineers, Society of the Chemical Industry (London), Sigma Xi, Alpha

Chi Sigma, and the Chemists Club of New York.

The deceased was born in Vienna on July 20, 1896.

He is survived by his wife, three sons, his mother, a brother, and a grandson.

Funeral services were held at the Waterman Chapel, Cambridge, February 12.

He remained on the board of directors, however.

The deceased leaves his wife and nine children, eight by two previous marriages.

Services were held January 30 for Mr. Jennings at Billow Funeral Home in Akron. Burial was in Greenlawn Memorial Cemetery.

Frank H. Jennings

Frank Harold Jennings, one of the founders of and a major stockholder in McNeil Machine & Engineering Co., Akron, O., died January 26 from injuries sustained in an automobile accident on an Akron highway.

He was born in Clinton, O., on January 14, 1895. He attended Barberton, O., public schools.

Mr. Jennings was one of five organizers of the rubber equipment manufacturing firm which came into being in 1936 upon the purchase of a predecessor's facilities. He was assistant secretary, assistant treasurer, and a director of the company until his retirement in 1953.

Albert Walter

Albert Walter, who retired in 1946 as chairman of the board of Stauffer Chemical Co., New York, N. Y., died January 28 at his home in Miami, Fla. He was 81.

He joined Stauffer in 1906 as a mining engineer and was placed in charge of the company's phosphate operations at Coleville, Wyo. Six years later he was named eastern division manager. He became general manager of the firm in 1934, president in 1942, and board chairman in 1945.

He is survived by his wife, a daughter, and three grandchildren.

Funeral services were held at the Hines Funeral Home, Washington, D. C., on February 1.

Financial

Aetna-Standard Engineering Co., Pittsburgh, Pa. Second half, 1955: net earnings, $558,573, equal to $1.32 a share, against $410,818, or $1.02 a share, in the corresponding period of the previous year.

American Cyanamid Co., New York, N. Y., and subsidiaries. For 1955: net profit, $36,569,768, equal to $4.07 a common share, compared with $25,739,973, or $2.95 a share, in 1954; net sales, $451,-088,434, against $397,591,904; income taxes, $36,000,000, against $24,000,000.

American Zinc, Lead & Smelting Co., Columbus, O. For 1955: net profit, $2,592,-232, equal to $2.20 a common share, compared with $1,811,164, or $1.54 a share, in 1954; sales, $76,743,142, against $64,-463,525; federal income taxes, $2,470,000, against $1,420,000.

Carborundum Co., Niagara Falls, N. Y. For 1955: net earnings, $5,187,055, equal to $3.01 a share, compared with $3,283,-704, or $1.92 a share, in 1954.

Crown Cork International Corp., Baltimore, Md., and wholly owned domestic subsidiary. Year ended December 31, 1955: net earnings, $903,586, equal to $2.33 a share, against $842,227, or $2.17 a share, a year earlier.

The Eagle-Picher Co., Cincinnati, O., and domestic subsidiaries. Year ended November 30, 1955: net income, $5,004,062, equal to $5.06 each on 989,177 capital shares, contrasted with $2,446,829, or $2.47 a share, in the preceding fiscal year; net sales, $114,480,080 (a new high), against $83,233,880; income taxes, $5,200,-000, against $2,500,000.

Endicott-Johnson Corp., Endicott, N. Y. Year ended November 30, 1955: net profit, $2,843,956, equal to $3.15 a share, against $2,135,249, or $2.28 a share, in the 12 months preceding.

Flintkote Co., New York, N. Y., and subsidiaries. For 1955: net income, $4,945,-693, equal to $3.40 a common share, compared with $5,095,787, or $3.72 a share, the year before; net sales, $100,995,-922, against $94,804,706; income taxes, $4,697,688, against $4,568,431; current assets, $37,017,076, current liabilities, $10,446,876, against $36,394,121 and $9,899,847, respectively, on December 31, 1954.

Johnson & Johnson, New Brunswick, N. J. For 1955: net profit, $11,311,904, equal to $5.38 a share, compared with $9,461,307, or $4.45 a share, the year before.

General Electric Co., Schenectady, N. Y. For 1955: consolidated net profit, $200-923,835, equal to $2.32 a common share, against $198,913,221, or $2.30 a share, a year earlier; sales, $3,095,352,063, against $2,959,077,548; provision for federal income taxes and renegotiation, $168,000,-000, against $191,700,000.

The General Tire & Rubber Co., Akron, O., and consolidated subsidiaries. Year ended November 30, 1955: net profit, $9,704,731, equal to $6.29 a common share, contrasted with $4,502,645, or $3.18 a share, in the preceding fiscal year; net sales, $295,731,096 (a record figure), against $216,986,110; income taxes, $10,-034,000, against $3,040,335; current assets, $122,800,564, current liabilities, $70,401,-419, compared with $100,408,670 and $55,-680,842, respectively, on November 30, 1954.

Goodyear Tire & Rubber Co., Akron, O., and subsidiaries. Year ended December 31, 1955: net earnings, $59,665,845 (a record), equal to $5.90 a common share, compared with $48,055,196, or $4.54 a share, in the preceding year; net sales, $1,372,176,139 (a new high), against $1,090,094,050; income taxes, $66,966,000, against $43,372,000; current assets, $547,-908,073, current liabilities, $87,355,323, against $468,872,166 and $106,817,786, respectively, on December 31, 1954.

Hercules Powder Co., Wilmington, Del. For 1955: net earnings, $19,012,125, equal to $6.90 a common share, compared with $14,140,070, or $5.10 a share, the year before; net sales, $226,651,058 (a record), against $187,547,566.

Hooker Electrochemical Co., Niagara Falls, N. Y. Year ended November 30, 1955: net profit, $10,555,000, equal to $1.75 a common share, compared with $8,202,000, or $1.36 a share, in the preceding fiscal year; sales, $94,182,000 (a new high), against $77,517,000.

Johns-Manville Corp., New York, N. Y. For 1955: net income, $23,511,183, equal to $7.37 a share, contrasted with $16,655,-658, or $5.24 a share, the year before.

National Automotive Fibres, Inc., Trenton, N. J. For 1954: net profit, $2,164,062, equal to $1.97 a share, contrasted with net loss of $543,394 the year before; sales, $83,482,551, against $56,688,095.

Parker Appliance Co., Cleveland, O. Second half, 1955: net earnings, $65,592, equal to 17¢ a share, contrasted with $586,480, or $1.51 a share, in the similar months of 1954.

Rome Cable Corp., Rome, N. Y. Nine months ended December 31, 1955: net profit, $1,370,000, equal to $2.86 each on 477,791 common shares, contrasted with $644,000, or $1.25 each on 513,421 shares, in the 1954 period.

(*Continued on page 876*)

News from Abroad

Malaya

U.K. Synthetic Plant Plans Get Some Reluctant OK's

No one in Malaya is happy about the news, mentioned in these columns recently, of the formation of the International Synthetic Rubber Co., by Dunlop, Goodyear, Firestone, and Michelin, to produce GR-S type rubber on a large scale in England. But while there have been protests, there also seems to be a tendency to take a realistic view of the matter.

"Novel and Wise" Plan

The *Straits Times* prints an article which describes the venture as both novel and wise—wise, because "no progressive rubber manufacturing industry can any longer exist without a generous supply of synthetic rubber"; and novel, because "a large-scale general-purpose synthetic rubber industry has never previously been established by private enterprise." The need of making synthetic rubber in the United Kingdom, says the writer, stems from a world shortage of rubber, as well as the superiority of GR-S type rubber for various uses.

World consumption of total rubber is increasing at the rate of about 100,000 tons per year, indicating the need of about 3,250,000 tons by 1960. This deficit "cannot possibly" be met by even modern plantations, and in any case no aid can be expected from large-scale replanting for seven to ten years. The demand for all kinds of natural rubber will continue for many years to come, although the "continuing and disturbing fluctuations in the price of natural rubber are providing every incentive for the chemical and rubber manufacturing industries to look for alternatives," it was said.

Since the rubber growing countries cannot be depended upon to produce the rubber that manufacturers will need ten years from now, British rubber manufacturers cannot be blamed for considering the establishment of synthetic factories in Britain to avoid being "caught napping," was the view expressed by Tan Siew Sin in the Legislative Council.

New Planting

In fairness it must be added that Mr. Tan's reasonable views on synthetic rubber were in the nature of a prelude to his main concern at the time, which was a scheme for large-scale new planting in Malaya. As he sees it, if the assumption is accepted that total world consumption will be 4,000,000 tons annually by 1965, against total production of all rubbers of about 2,900,000 tons in 1955, the world will need more than 1,000,000 tons of new rubber. Malayan output in 1955 is put at about 630,000 tons, and the best that can be expected now is an increase in Malayan production of 400,000 tons in ten years—if present replanting schemes are thoroughly successful.

Mr. Tan is not optimistic about Indonesia's possible contribution to new rubber; present conditions lead him to believe production there is more likely to decrease rather than increase, so that an immense deficit would remain. He therefore advocates the planting of 1,000,000 acres of new rubber besides replanting. By this, he calculates, Malaya's direct revenue would be raised by $132,000,000 (Straits), to say nothing of increased indirect revenue. He condemns the existing policy of restricting the increase of production through new planting in the mistaken belief that new planting plus replanting would create a world surplus of rubber. On the contrary, the danger is in not producing enough and thus encouraging synthetic output.

These statements brought instant response. From Kuala Lumpur came the suggestion that the government appoint a committee of experts to determine the value of opening up new land.

G. M. Knocker, chairman of Harrisons & Crosfield (Malaya), Ltd., stressed that it should be recognized that large areas of virgin land might not be economically fit for any major crop other than rubber. He foresaw no problems as concerned plantations if land were made available, and the government gave assurance that present excessive taxation would be reduced, and the rights of overseas capital adequately protected. But there might be difficulties in persuading smallholders to move to other districts to start new rubber.

Fears Nigeria Rubber

Malaya is in danger of fostering a potentially strong competitor in Nigeria by her discriminatory rubber taxation policy, Sir John Hay warned when he visited Malaya last January on a business tour of the Federation and Singapore. Sir John, managing director of Guthrie & Co. in London, considered that the tax on rubber was too high and, if continued, might divert new foreign capital to Nigeria, where the prospects of the rubber industry are good and taxes low.

Commenting on this statement, C. E. T. Mann, director of the Rubber Research Institute of Malaya, asserted that it would be many years before Nigeria could develop a rubber industry that would be a serious threat to Malaya. Nigeria's present output is between 15,000 and 20,000 tons a year, he pointed out, and had a long way to go to catch up with Malaya. He admitted, however, that rubber could be grown in Nigeria, and that the local government was keenly interested. Nigeria is a contributor to the Malayan Fund, Mr. Mann added, and thereby entitled to information from the R.R.I. in Malaya and Britain, and from the Natural Rubber Bureau and Rubber Development Bureau, in America. Last year the Nigerian Government sent a senior agricultural officer to Malaya and Ceylon to gather first-hand information.

1955 Rubber Output Up 10%

Official statistics issued late in January showed that rubber production in Malaya in 1955 was 637,463 tons, 9.34% over the 1954 total and the best figure since 1950. It may fairly be said that the increase over 1954 output was almost entirely due to the spurt in activity by smallholders in response to high prices; favorable weather conditions also helped. While estates accounted for 352,182 tons, or 2.75% more than the year before, smallholders, tapping heavily to get as much rubber as possible while prices remained high, increased their output 18.75% over that of 1954, to a total of 285,281 tons.

Total rubber imports into Malaya also improved and at 362,300 tons were 5.2% over those of 1954 and the best since 1951. Imports from Indonesia, however, declined from 299,339 to 286,548 tons as a result of the sharp drop in arrivals from Sumatra (185,588, against 226,598 tons), which substantial increases in shipments from Java and Indonesian Borneo could not make good. It is to be noted that while lower grades constituted 33.6% of the total imports in 1954, the proportion was only 15.58% last year.

Exports High in 1955

Malaya exported 994,176 tons of rubber in 1955 (export and reexports), 8% more than in the preceding year. All leading consuming countries except Italy increased their offtake as is seen in the following table giving amounts and percentage increase or decrease over 1954 figures:

	Tons	% Increase or Decrease
Britain	236,846	+17.37
United States	182,896	+24.69
France	88,568	+2.10
Western Germany	86,752	+16.00
Japan	71,356	+5.94
Italy	53,209	−3.58
Argentina	31,629	+47.46

Conspicuous in this table is the spectacular rise in shipments to Argentina, almost half as much again as in the preceding year.

In 1955 ribbed smoked sheet accounted for 62.55%, or 621,955 tons, of the total, and latex for 10.84%, or 107,806 tons; in 1954, with total exports at 915,114 tons, ribbed smoked sheet accounted for 61.23%, and latex for 10%.

The demand for latex from Malaya by countries all over the world has been growing steadily in recent years, and exports in 1955 were 16.71% above those of 1954 and 123.6% higher than in 1952. The big increase in 1955, however, was largely the result of much larger purchases by the United States. Of exports totaling 107,806 tons, the United States took 41.93%, or 45,212 tons, 64% higher than in 1954.

The amounts of latex taken by the chief customers in 1955 and the percentage increase or decrease over 1954 figures follow:

	Tons	% Increase or Decrease
United States	45,212	+64.00
Britain	31,127	+3.18
Western Germany	7,103	−16.35
France	4,965	+4.96
Japan	3,230	+26.86
Australia	3,618	+35.40

The substantial increases by Australia and Japan in addition to the United States are as marked as the sudden drop in purchases by Western Germany.

More Slab Rubber Imports?

The supply of slab rubber from Indonesia to Malaya dropped considerably last year, to the detriment of the remilling industry of Singapore. In 1955, only 36,095 tons of slab rubber arrived, against 101,000 tons in 1954 and a high of 132,000 tons in 1950. As a result, half of the 12 remilling establishments in Singapore and about three-fourths of the estimated 460 mangles have been completely idle for many months. The remillers in Singapore employ more than 5,000 workers, of whom only some 1,000 could be retained, and many even of these have been working on a rotation basis.

During the good-will tour of Indonesia in the latter part of 1955 by the Chief Minister, David Marshall, the release of 12,000 tons of slab rubber had been promised; consequently recent arrivals have been heavier. They are likely to be further increased when the British Government grants Mr. Marshall's plea, made when on a mission in London recently, to release a percentage of hard currency to satisfy Indonesian terms for her products imported by Singapore for reexport. An immediate result of improved slab-rubber supplies was the reopening of a seventh remilling factory which had been idle for almost eight months.

Rubber Workers Wage Cut?

The drop in the price of rubber during the last quarter of 1955 will mean a cut in wages for the Federation's 320,000 rubber estate workers, a joint circular issued by the National Union of Plantation Workers and the M.P.I.E.A. has warned. During the first quarter of 1956 wages will be based on the \$1.20-\$1.30 price zone, and workers will thus earn \$56,000 a day less than they earned during the last quarter of 1955. Price trends so far indicate a possible further cut for the second quarter of 1956.

Synthetic Rubber Here?

What to Malayan rubber growers must be a startling result of high natural-rubber prices is the attempt to introduce the much cheaper synthetic product to industries right here in Malaya. A local firm is said to be offering a whole range of Canadian polymers, apparently obtained through Hong Kong where they have been making headway, especially in the footwear industry. The rubbers, many of which sell at less than half the natural rubber price, are being shown to Malayan manufacturers using rubber, and a campaign is being planned to induce factory managers to give them a trial, it is reported.

The propaganda, it is believed, may succeed with tire retreaders, since the polymer for their purpose has high abrasion qualities and costs about 72 cents (S. S. currency) a pound delivered to Malayan port; whereas the high-grade sheet cuttings generally employed by retreaders and also footwear factories, now cost about \$1.02 a pound. The shoe factories are expected to prove indifferent as the price differential would mean less to them, and the larger firms still find cyclized rubber economical.

The Rubber Research Institute, it is said, plans testing the various polymers being offered here, and has ordered suitable quantities for this purpose.

To Map Rubber's Future

The Rubber Producers' Council has finally decided that the time has come to take definite steps toward planning the future of the natural rubber industry. Since the last five-year plan ended in 1953, the industry has been without a program of research and development, a situation that has evoked much criticism all over the world. Now the R.P.C. has appointed a committee in London to study all aspects of the rubber industry both in Malaya and the United States and then to advise on the type of research and development which will most likely enable natural rubber to meet the competition from synthetic rubber. It is understood that Prof. Geoffrey Emmett Blackmann, of Oxford University, and director of the Agricultural Research Council Unit of Experimental Agronomy in Britain, has accepted the R.P.C.'s invitation to be chairman of the committee. The R.P.C. will probably ask the government to help finance new research and development.

It is likely that the future program may include setting up a laboratory service for natural rubber in the United States. The idea, which came from a former superintendent of the London Advisory Committee on Research, G. Martin, following his investigations in America, has reportedly been taken up by prominent rubber circles here, and it is hoped that the R.P.C. research planning committee will consider establishment of a laboratory service in the United States in addition to the road laboratory service now run by the Natural Rubber Bureau. The point was made that producers of synthetic do not leave sales of their products to chance or price advantage, but freely offer advice to manufacturers.

No Replanting Restriction

The Malayan Government announced no restriction will be set on the amount of replanting or new planting which may be carried out under the rubber replanting scheme this year. Earlier it had been stated that a ceiling might be necessary to avoid any bottleneck in the supply of suitable planting material.

The grant to aid replanting is payable to estates and smallholders also when alternative crops as coconuts, cocoa, coffee, pineapples, oil palms, teas, fruit trees, are grown to replace old rubber. A few of the larger estates already have taken advantage of this provision to extend existing areas of oil palm and embark on tea and cocoa growing.

According to data supplied by the acting Chief Replanting Officer, J. Fairweather, roughly 10% of the area replanted by smallholders since 1952 is under crop other than rubber. In that period 82,652 acres were replanted with rubber, and 8,074 acres with coconuts, fruit trees, coffee, pineapples, padi and sago, in that order. The trend continued in 1955; 1,721 applications were approved for planting 4,922 acres with other crops, and 10,416 approved applications for growing 43,955 acres of rubber.

Dunlop Replanting Program

The revelation that Dunlop Plantations has since 1950 been engaged in a replanting and building program to cost \$5,500,000 by 1962, has received much favorable comment here as substantial evidence of Dunlop's faith in the future of Malaya and of natural rubber. When the program, which includes the expenditure of £4,500,000 on replanting and new planting and £1,000,000 on rebuilding and modernization of factories, living quarters, clubs, and playing fields, is completed in 1962, 72,500 acres are expected to be under high-yielding rubber. At the same time the number of workers, at present 12,000, will probably be nearer 16,000.

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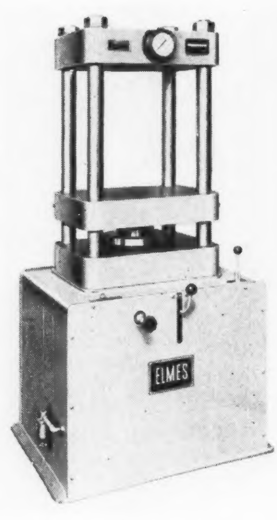
Japan

To Make Synthetic Rubber?

The manufacture of synthetic rubber is being seriously considered in Japan. Reports from Tokyo state that three Japanese chemical companies—Japanese Geon Co., San-Yo Chemical Co., and Mitsubishi Chemical Synthetics Co.—have applied for government permission to set up plant for producing general-purpose synthetic rubber. Manufacture would be based on petroleum, and it is said that the Japanese companies believe they can produce synthetic rubber at the equivalent of U. S. 25¢ per pound, which is 2¢ less than the cost of imported synthetic rubber.

Japan imported about 90,000 tons of natural rubber in 1954, of which Malaya supplied around 70%, and only about 2,200 tons of synthetic rubber.

NEW EQUIPMENT

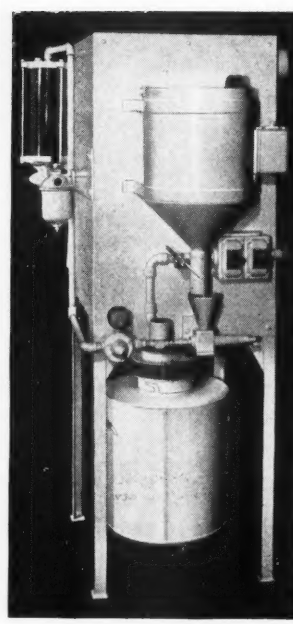


Elmes Engineering Hydrolair Press

Hydraulic Presses in 75- and 100-Ton Sizes

Air - powered hydraulic presses in 75- and 100-ton sizes have been made available by American Steel Foundries, Elmes Engineering Division, Cincinnati, O., as an addition to its 30- and 50-ton sizes previously offered. Called Elmes Hydrolair presses, they are available with either hand-lever or optional electric push-button control. A special hydraulic intensifier provides a continuous high-pressure stroke and maintains any preset pressure for as long as desired, the company says.

Suggested uses for the new presses are rubber and plastics molding, laminating, and laboratory test work.

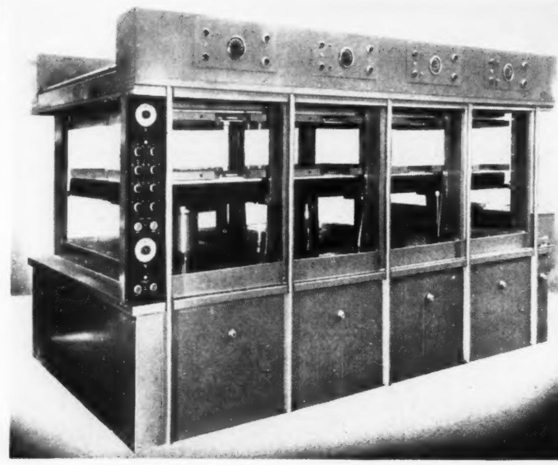


Model DI Craig unit and collector

Powder Dispersing and Confining Machine

Equipment for the dispersal and confinement of powdered material in air, in a high degree of fineness and in desired density, precluding the possibility of plant atmosphere contamination and accompanying health and fire hazards, has been developed by and is available from Craig Corp., New York, N. Y. The device is said to be valuable to such industrial processes as the dusting of rubber, plastics, and coated fabrics; the blending of several dry powdered materials, such as powdered resin; and other manufacturing operations requiring the use of powdered materials.

The device is compartmentalized; one or more chambers can be used to dust one or both sides of a sheet material and may be equipped with electronic means for dust precipitation, according to the company. Brushes, drags, wipes, and/or hot or cold calendering, or squeeze rollers, either inside or outside the chamber, may also be employed, as well as a secondary heated chamber if the powdered material is to be softened or melted, such as wax or resin. Various models and sizes of the machine are available.

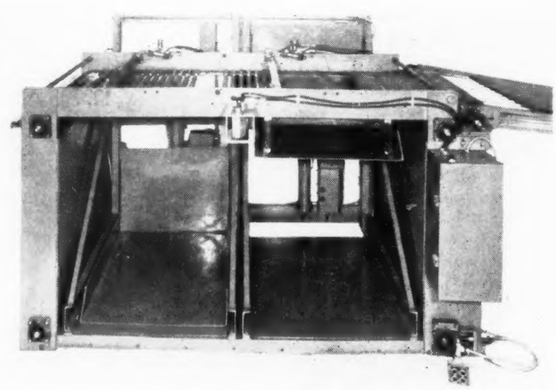


PHI Multi 560-ton press

Eight-Unit Multiple Press

A 560-ton press said to meet the requirements of manufacturers involved with dies and molds of wide variance in sizes and applications has been added to the press line of Pasadena Hydraulics, Inc., Pasadena, Calif. Called PHI Multi 560-ton press, it has a central control panel which coordinates all or any two of the grouping rams. Separate controls at each station permit the machine to be operated as independent 8-70-ton presses.

The press has a 54- by 110-inch total platen area, or eight 24½- by 24½-inch press units, each including upper and lower platens with cast-in 8000-watt heaters; eight 70-ton rams; a nine-inch stroke with opening adjustable to 18 inches; and motorized high- and low-pressure pumps that are said to provide quick closing and pressure build-up on one or any group of units selected. This press, furthermore, has a welded steel stress-relieved construction.



Spadone's Alfa automatic stacker with two stations

Machine for Production-Line Stacking

A stacking machine for a wide range of materials, including milled and calendered rubber stock, has been placed on the market by Spadone Machine Co., Inc., South Norwalk, Conn. Dubbed Alfa automatic stacker, the unit is said to have speeds up to and exceeding 100 feet a minute, employing a simple mechanical action and stacking materials for easy take-away from the production line.

The machine is furnished as a unit or in combination with the company's Alfa rotary cutter that measures and cuts materials to specified lengths prior to stacking. The stacker is available in various height and weight capacities and with one or two stacking stations.

NEW MATERIALS

Cadmium-Barium Liquid Stabilizers

Two cadmium-barium type of liquid stabilizers for polyvinyl chloride resins and copolymers have been placed on the market by Harwick Standard Chemical Co., Akron, O. Called Stabelan 110 and Stabelan 115, they are said to be compatible with all currently used vinyl chloride polymers and copolymers, primary and secondary plasticizers, as well as organic and inorganic pigments. These Stabelans are both efficient heat and light stabilizers and produce films and sheetings of a high degree of clarity. Both are insoluble in water and soluble in naphthas, cyclic hydrocarbons, ketones, and plasticizers. Stabelan 110 has a specific gravity of 1.006; while that of Stabelan 115 is 1.015.

Steel-Grit Blast Abrasive

A new steel-grit blast cleaning abrasive for producing an etched finish on metals to facilitate bonding with such materials as rubber, plastics, enamel, and paint has been introduced by Wheelabrator Corp., Mishawaka, Ind. Called Steeletts, the product is composed of specially heat-treated high-carbon electric arc furnace steel chips which are said to maintain their cutting edges for hundreds of operative cycles. Seven sizes are available, ranging from G-16 to G-120, all screened to SAE specifications.

PVC Stabilizer—Advastab X23-30

A new heat and light stabilizer said to be suitable for straight polyvinyl chloride as well as copolymer resins, and recommended for all types of vinyl operations, such as calendering, extrusion, and plastisol applications, has been introduced by Advance Solvents & Chemical Corp., New York, N. Y. Called Advastab X23-30, the material is a clear liquid barium-cadmium system said to be advantageous over similar systems in not requiring an epoxy plasticizer in the formulation.

Reported specifications include the following:

Color, (G.H.)	11
Viscosity, @25° C.	U (Gardner) (600-700 cp.)
Specific gravity, @25° C.	1.059
Refractive index, @25° C.	1.4900
Odor	very slight
Pounds per gallon	8.84

A technical data sheet describing the stabilizer and its applications is available from the company.

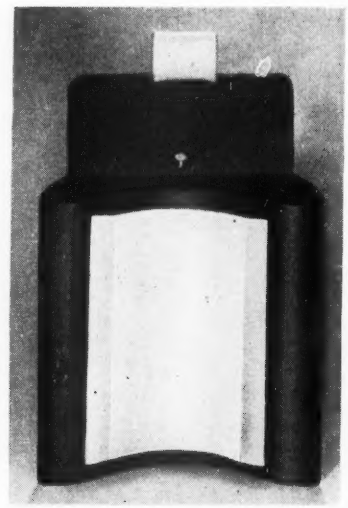
Kel-F and Glass Cloth Laminate

A new fluorocarbon plastic laminate that can be adhesive-bonded to almost any contoured surface for use where high temperatures and corrosive chemicals are present has been developed by M. W. Kellogg Co., New York, N. Y. The laminate consists of a thin layer of Kel-F Plastic on glass cloth. It can be cut easily and cold or hot formed to flat or curved surfaces, such as the surface of tables or floors or the interior of reactors, drums, and pipes. The laminate is available in 36- by 46-inch sheets.

"Mobay—the Urethane Story." Monsanto Chemical Co., St. Louis, Mo. Applications of the new urethanes in flexible and rigid foams, paints, wire coatings, synthetic rubber, and adhesives are described and illustrated in this booklet.

NEW PRODUCTS

Freight-Car Sponge Rubber Lubricator



Top view of U. S. Rubber's Ever-Pac

A sponge rubber lubricator designed to end the perennial journal hot box, said to be the railroads' most costly freight-car operating problem, and to save them a reported $200,000,000 a year, has been developed by United States Rubber Co. Called Ever-Pac, the lubricator forms a sealed oil reservoir at the bottom of the journal box and pumps, squeezes, and wick-feeds filtered oil into a felt pad that is in constant contact with the rotating journal, giving controlled and fully adequate journal lubrication, according to the company.

The device eliminates waste-grab, the major cause of hot boxes, as well as the expense of waste renovation and replacement, cuts oil consumption by more than a half, and sharply reduces original installation and replacement costs, U. S. Rubber states. Ever-Pac consists of an absorbent synthetic sponge rubber pad resistant to oil, acids, heat, and abrasion, with an absorbent felt wick-pad fitted to the top surface of the sponge rubber like a saddle.

Goodrich Boat Trailer Tire

A tire said to be designed specifically for boat trailers has been put on the market by The B. F. Goodrich Co., Akron, O. The tire resembles house trailer tires in that it meets the requirements of free-rolling wheels, the company says. Of four-ply construction, it is available in size 4.80/4.00-8 and fits regular or wide-base rims.

Parker O-Rings for Hydraulic Fluids

Synthetic rubber O-rings for use with aviation hydraulic fluids have been developed by Parker Appliance Co., rubber products division, Cleveland, O. The O-rings are suitable with MLO-8200 and Monsanto OS-45 fluids, among others, at temperatures from —65 to 400° F., according to the company.

The synthetic rubber material from which the O-rings are made has been designated Parker Compound 66-103.

One-Piece Neoprene-Coated Coverall

A one-piece woven cotton coverall coated on both sides with neoprene has been introduced by Industrial Products Co., Philadelphia, Pa. The suit is intended to protect workers from acids or oils in industrial plants, is black in color, has a full-length zipper with protecting fly front, and is vulcanized at all seams. Cuffs are tight fitting. Sizes are small, medium, and large.

Rolli-Tanker, $3\frac{1}{2}$ by 5 feet, mounted on hubs and axles

Goodyear Rolli-Tanker

A $3\frac{1}{2}$- by 5-foot watermelon-shaped rubber tank for the bulk transportation and storage of fuels and other liquids has been developed by The Goodyear Tire & Rubber Co., aviation products division, Akron, O. Called Rolli-Tanker, the container has a tire-like tread and is mounted on hubs and axles for manual or vehicular towing. Of nylon cord and rubber tread stock construction, the Rolli-Tanker has a 250-gallon capacity, weighs 40 pounds when empty, and can be rolled over the ground, floated in water, or dropped without bursting.

Super-Master BW Neoprene Hose

A high-visibility yellow-covered neoprene hose with braided steel wire construction is being offered by Manhattan Rubber Division, Raybestos-Manhattan, Inc., Passaic, N. J. Dubbed Super-Master BW Air and Super-Master BW Water, for air or water use, the hose is said to be strong enough for air actuating service on the heaviest machinery and loading equipment, yet is light and flexible enough for pneumatic tools. The neoprene tube, it is said, is resistant to hot oil from equipment as compressors.

Thorobred D. S. Traction Tire

A new truck tire "designed to meet the demands of stop-and-go operations" has been introduced by The Dayton Rubber Co., Dayton, O. Known as Thorobred D. S. Traction Tire, it is said to have such features as a wider tread, self-cleaning traction lugs, and electronically processed cord body. The tread has high resistance to cuts, cracks, and chips, according to Dayton.

Puf-foam Polyurethane Sponge

A household and industrial polyurethane sponge whose absorption qualities can be increased to any desired degree by pounding with a blunt instrument has been placed on the market by Alpha Chemical Co., Los Angeles, Calif. Called Puf-foam, the sponge is made from American Latex Products Corp.'s Stafoam polyurethane, is resistant to all household and most industrial chemicals, can be sterilized by boiling, and is wear-resistant, according to the producer. Various sizes are available.

Veri-Lite Garden Hose

A lightweight rubber garden hose that has a synthetic yarn woven into the carcass for added strength has been placed on the market by Boston Woven Hose & Rubber Co., Boston, Mass. Dubbed Veri-Lite, the hose is said to be flexible in all temperatures and has high wear resistance. Produced in an inside diameter of one-half inch, the hose is available in red and green colors.

TECHNICAL BOOKS

BOOK REVIEWS

"Prüf-, Mess- und Kontroll-Geräte-Lexikon, 1954." Edited and compiled by Hans Hadert. First Edition. Published by Hadert-Lexikon-Verlag, Martin Luther Strasse 88, Berlin W. 30, Germany. Board covers, 8¼ by 6 inches, 750 pages. Price D. M. 38.00, plus postage and packing.

Numerous inquiries over a long period of years, the editor says in his foreword, revealed that even in large factories there was often complete ignorance about many serviceable testing, measuring, and checking instruments. At the same time came frequent requests for a reference book giving helpful information about types of devices required to solve specific manufacturing problems. Since no such work has hitherto been available, either in Germany or abroad, Hadert undertook to fill this lack and now presents the 1954 lexicon of testing, measuring, and recording instruments, the first of its kind, it is claimed.

In 96 sections, including several hundred illustrations, all kinds of modern German and foreign devices for the most varied purposes are described, and many of the chapters close with a bibliography that should prove valuable to those wishing to go deeper into the respective problems. Rubber and plastics manufacturers will find, among others, devices for checking, determining or testing Redox values, elasticity, porosity, melting, softening and flow points, abrasion, aging, flash and ignition points, effects of climate, dimensional stability, permeability, also X-ray, ultrasonic, dialysis, and ultra-filtration equipment.

The use of this lexicon is facilitated by two indices, one giving the names or purposes of the devices, and the other the industries covered.

"Rubber Red Book." 1955-56 Edition. *Rubber Age*, New York, N. Y. Cloth cover, 6 by 9 inches, 1249 pages. Price, $10.

This tenth edition of the Red Book supplies data on 1,410 rubber manufacturers in the United States and Canada, giving concise information on executive personnel and types of products manufactured. Sections listing manufacturers of equipment, accessories, compounding materials, textiles, among others, are, as usual, included. Special sections are devoted to natural, synthetic, reclaimed, scrap, and latex rubber. The "Who's Who" is again a particularly valuable feature. Other sections include information on sales and export agents, educational courses planned or being given, trade and technical organizations, and technical journals.

NEW PUBLICATIONS

"Your Fact File on Diamond Chlorowax." Diamond Alkali Co., chlorinated products division, Cleveland, O. 36 pages. This manual discusses and illustrates the applications of the firm's chlorinated paraffins in the rubber, plastics, adhesives, and fabric finishing industries.

"Para Coumarone Indene Resins." Bulletin #12-64-5-12-55. Harwick Standard Chemical Co., Akron, O. 6 pages. The uses of the firm's Piccoumaron resins in rubber compounding are detailed in this publication, as well as sample GR-S recipes employing them and postcure test data.

"Naugatuck Plastics Condensed Catalog—1955-1956." Naugatuck Chemical Division, United States Rubber Co., Naugatuck, Conn. 12 pages. Properties and applications of the firm's Kralastic, Vibrin, and Marvinol resins are reported here.

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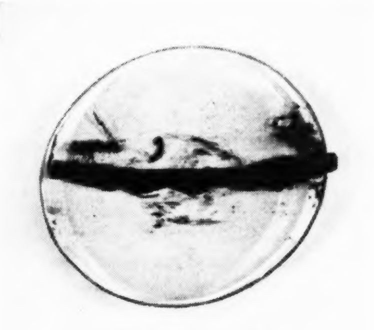
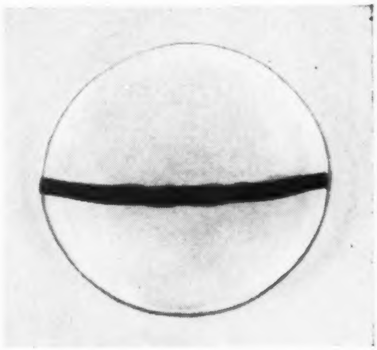
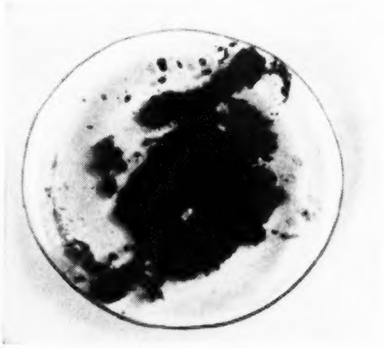


BUNA-N — 10 min. immersion in RFNA

NATURAL RUBBER — 10 min. immersion in RFNA



BUTYL — 2 hr. immersion in RFNA



GRS — 10 min. immersion in RFNA

KEL-F ELASTOMER — one week immersion in RFNA

IMMERSION IN RED FUMING NITRIC ACID for one week has no appreciable effect on the physical properties of KEL-F Elastomer. Extensibility and hardness remain virtually unchanged. Other available rubbers disintegrate within a matter of minutes.

When severe operating conditions demand a chemical rubber that *must* stand up under high temperatures and corrosive atmospheres—KEL-F Elastomer is the answer.

Developed by Kellogg, KEL-F fluorocarbon rubber combines superior elastomeric properties with excellent chemical resistance and thermal stability. Other outstanding advantages include: high chemical resistance to solvents, fuels and lubricants . . . low moisture absorption . . . non-flammability . . . excellent resistance to weathering and microorganisms.

This *unique* combination of properties makes KEL-F Elastomer useful in applications such as heat-and-chemical-resistant hose, tubing, diaphragms, gaskets, seals, tank linings, corrosion-resistant clothing, paints, flame-resistant coatings, and electrical insulation.

If your work requires an elastomer with outstanding resistance to heat and corrosion, look into KEL-F Elastomer. Our technical staff is prepared to assist designers, engineers, and production men in adapting KEL-F Elastomer to their individual needs. Kellogg supplies KEL-F Elastomer in the gum form only. Names of qualified fabricators of specific end uses of KEL-F Elastomer are available on request.

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"Trouble-Shooting Chart for Hydraulic Systems." Sun Oil Co., industrial products department, Philadelphia, Pa. Intended for shop display, this chart gives causes and cures of defects in hydraulic systems.

"Harvest of Research." David Dietz. The Goodyear Tire & Rubber Co., Inc., Akron, O. 54 pages. Mr. Dietz, science editor of the Scripps-Howard newspapers, describes Goodyear's entry into the field of chemical materials and the creation of its chemical division. The division's contributions to the rubber, paint, plastics, textile, and paper industries are discussed in this illustrated book.

"Ucon Fluids and Lubricants." Form 6500D. Carbide & Carbon Chemicals Co., division of Union Carbide & Carbon Co., New York, N. Y. 52 pages. Properties, uses, and test data of the company's polyalkylene glycol-type fluids and lubricants are included in this engineer-slanted booklet.

"Bondmaster Adhesives Series 'M' for Plastics and Metals." Rubber & Asbestos Corp., Bloomfield, N. J. 2 pages. This chart lists a variety of technical data on the company's adhesives for bonding plastics and metals.

"Metal Forming Bulletins." Marblette Corp., Long Island City, N. Y. 8 pages. The manufacture, uses, and advantages of plastic draw dies, stretch press dies, and hydro-form dies are outlined in this series of bulletins.

"Explore, Expand, and Diversify with Surface Chemistry at Foster D. Snell, Inc." Foster D. Snell, Inc., New York, N. Y. 8 pages. The role of surface chemistry in modern technology, including the preparation of synthetic rubber by emulsion polymerization, is described in this booklet.

"Survey of Cachalot Fatty Alcohols." M. Michel & Co., Inc., New York, N. Y. 12 pages. Technical data on the company's straight-chain aliphatic alcohols, including typical reactions and solubility charts, are included in this booklet.

"Consider These Factors When Choosing an Industrial Truck." The Elwell-Parker Electric Co., Cleveland, O. 4 pages. Such features in an industrial lift truck as capacity, lift, total weight and size, battery capacity, and location of operator and truck controls are discussed in this folder.

"Sequestrene Bibliography (1953-1954)." Geigy Industrial Chemicals, New York, N. Y. 20 pages. This is a collection of references to published papers, arranged alphabetically by author, concerning ethylenediamine tetraacetic acid, the company's Sequestrene. Digests of the articles are given.

"Anaconda Type AB Butyl Rubber High-Voltage Insulation." Publication No. EB-27. Anaconda Wire & Cable Co., Hastings-on-Hudson, N. Y. 12 pages. Reported in this booklet are test data on the company's Type AB Butyl insulation, such as ozone resistance, dielectric strength, corona level, mechanical and electrical moisture absorption, and others.

"Development of Ozone and/or Oxygen Resistant Polymers." PB 111722. Office of Technical Services, United States Department of Commerce, Washington 25, D. C. 105 pages. Price, $2.75. This is a report of a recent experimental program conducted by Burke Research Co. for the U.S. Army Ordance Corps in an effort to improve the ozone resistance of GR-S type rubber tire stocks. Among the results achieved was the discovery that some additives would improve the ozone resistance of these stocks by as much as ten times.

"Potassium Titanium Fluoride" and **"Potassium Zirconium Fluoride."** Bulletins 101 and 102. Kawecki Chemical Co., New York, N. Y. 1 page each. Physical and chemical properties and analyzed constituents of these compounds, both coagulation delay agents for rubber latex, are reported in these data sheets.

"Vulcan 6 in Oil-Extended GR-S Treads." RG-101. Godfrey L. Cabot, Inc., Boston, Mass. 24 pages. This is a report of road tests conducted on tire treads compounded of oil-extended RS and the company's Vulcan 6, an intermediate super abrasion furnace black. Evidence is presented that this tread can be made more cheaply than an HAF and cold RS tread and can give appreciably better wear. Test comparisons are presented between Vulcan 6 and Vulcan 3 in cold RS and in oil-extended RS; Vulcan 6 in blends of oil-extended RS and cold RS; different loadings of Vulcan 6 in oil-extended RS; and Vulcan 6 and Vulcan 3 in natural rubber and in a blend of Krynol and natural rubber. Tread formulations and compound costs are also given.

"The Replacement of Natural Rubber with GR-S in Non-Black Molded Goods." Hi-Sil Bulletin No. 8. Columbia-Southern Chemical Corp., Pittsburgh, Pa. 4 pages. Recipes and compounding data for the substitution of GR-S for natural rubber in non-black molded goods are reported here.

"Farrel Speed Reducers." Bulletin 450. Farrel-Birmingham Co., Inc., Ansonia, Conn. 50 pages. Horsepower rating tables, specifications, dimensions, weights, and other data on the company's speed reducers are included in this catalog.

"Ethanolamines." Allied Chemical & Dye Corp., nitrogen division, New York, N. Y. 54 pages. The applications and chemical, physical, and physiological properties of the company's ethanolamines are reported here, together with a comprehensive bibliography on the materials.

"101 Atomic Terms." Esso Research & Engineering Co., New York, N. Y. 20 pages. Words and phrases used in the atomic sciences are defined in this small illustrated booklet.

"Monoplex S-70." Rohm & Haas Co., Philadelphia, Pa. 5 pages. These technical data sheets report the properties and performance of Monoplex S-70 (formerly Monoplex AG-280), a low-temperature plasticizer for vinyl resins.

"Modernlab." Modern Laboratory Equipment Co., Inc., New York, N. Y. 12 pages. This is an illustrated catalog of the company's complete line of constant temperature equipment, including sterilizers, ovens, incubators, and baths.

"Tall Oil for Resins—Part IV." Bulletin No. 16. Pulp Chemicals Association, New York, N. Y. 4 pages. Suggested uses of tall oil in the rubber, latex paint, and resin industries, together with literature references, are included in this issue of "Tall Oil in Industry."

"Silicone Rubber O-Rings." Technical Data Sheet No. 103. Bacon Industries, Inc., Watertown, Mass. 6 pages. Specifications of the company's silicone rubber O-rings and data describing the physical properties of a new Teflon-silicone compound called X-5-8 are included on these data sheets.

"Baldwin-Tate-Emery Universal Testing Machines." Bulletin 4401. Baldwin-Lima Hamilton Corp., Philadelphia, Pa. 12 pages. Described and illustrated in this booklet are the company's hydraulic testing machines with capacities ranging from 10,000 to 5,000,000 pounds, together with an explanation of hydraulic loading and the independent hydraulic weighing system.

"Buffing and Polishing Compounds." Bulletin No. Co-103. Hanson Van Winkle-Munning Co., Matawan, N. J. 24 pages. Characteristics and uses of more than 100 of the firm's buffing and polishing compounds are contained in this booklet, together with a chart recommending compounds to be used with a variety of hard rubber, plastics, and metals.

"Silvacon." Bulletin 10-A. Weyerhaeuser Timber Co., Tacoma, Wash. 4 pages. Physical and chemical properties of the firm's Silvacon extenders, fillers, and additives derived from Douglas fir bark are included in this brochure.

Publications of The B. F. Goodrich Chemical Co., Cleveland, O.:

"Hycar Latex Newsletter." Issue No. 10. 8 pages. Discussed here are recommended stabilizers for Hycar latex and the drying of Hycar 1577 films, with comparative technical data illustrating both subjects.

"Properties of Hycar Latices." 2 pages. Physical properties of Hycar latices are reported in this chart.

Publications of E. I. du Pont de Nemours & Co., Inc., elastomers division, Wilmington, Del.:

"Properties of Rigid and Semi-Rigid Urethane Foams." HR-1. 24 pages. This booklet contains a discussion of the beneficial range of physical properties of the new urethane foams, illustrated with data curves.

"Chemistry of Organic Isocyanates." HR-2. R. G. Arnold, J. A. Nelson, and J. J. Verbanc. 38 pages. The various syntheses of organic isocyanates are here described, together with the polymerization reactions of the isocyanates with various materials.

"Urethane Resilient Foams Made from Polyesters." HR-10. W. J. Remington and R. H. Walsh. 14 pages. The physical and chemical properties and preparation of the new urethane foams are discussed in this booklet. Comparison of urethane and natural rubber foams is made.

"'Hypalon' Synthetic Rubber." 8 pages. This illustrated sales brochure gives the properties and applications of "Hypalon" chlorosulfonated polyethylene.

"Vinyl Foam." Elastomer Chemical Corp., Newark, N. J. 14 pages. The properties and uses of the company's foamed vinyl resin are discussed in this booklet.

"Automatic Bulk Weighing Scales." Bulletin No. 89[illegible]A. Richardson Scale Co., Clifton, N. J. 6 pages. Three models of the company's Class 38 automatic bulk weighing units are pictured and described in this folder.

"Lever-Lock Quick-Opening Door." Bulletin No. 2030. Patterson-Kelley Co., Inc., East Stroudsburg, Pa. 4 pages. Photographs and descriptions of the company's quick-opening doors for heat exchangers, sterilizers, and autoclaves are contained in this brochure.

"How Thick Should a Rubber Roll Covering Be?" Report No. 8. Rodney Hunt Machine Co., Orange, Mass. 2 pages. Reported in this data sheet is a graphical analysis of the effect of rubber thickness on nip width and distribution of pressure under the nip for a pair of squeeze rolls, as well as other related engineering data.

"25 Questions Most Frequently Asked about the Microlimit Control." Bulletin I-56. Industrial Gauges Corp., West Englewood, N. J. 6 pages. A question-and-answer discussion of the company's system of continuous, non-contact measurement and automatic control of diameter of insulated wire in production is contained in this publication.

"Parker O-Ring Sizes and Compounds Chart." Catalog 5701. The Parker Appliance Co., rubber products division, Cleveland, O. 12 pages. This catalog contains cross-reference charts of size numbers with dimensional data for all Parker O-rings for sealing applications, as well as data on the company's synthetic rubber compounds.

"Accident Prevention Manual for Industrial Operations." Third edition. National Safety Council, Chicago, Ill. 1,341 pages. Price, $13.50. This third edition of the Manual covers the whole field of industrial safety. The previous volume has been extensively revised and new information incorporated. Both the general subject of industrial safety and applications to specific industrial operations are discussed. Accident statistics are included.

"Speedwalk Passenger Conveyor System." Stephens-Adamson Mfg. Co., Aurora, Ill. 8 pages. The firm's passenger conveyor belts and equipment are described, and existing installations pictured.

"Silastic Newsletter." Vol. III, No. 4. Dow Corning Corp., Midland, Mich. 4 pages. The technique of splicing tubular silicone rubber extrusions where a removable, metal splicing mandrel cannot be used is described in this issue. A résumé of the properties and applications of Silastics is also included.

"Silastic Newsletter." Vol. III, No. 5. 3 pages. Among the subjects discussed in this Newsletter are the resistance of Silastic 50 and 152 to detergent, silastic gums, sponging of silastic, and water vapor transmission of Silastic.

Publications of The B. F. Goodrich Co. Tire & Equipment Division, Akron, O.:

"All You Need to Know About Tubeless Tires for Trucks." 12 pages. The servicing, repair, and advantages of the company's tubeless truck tires are discussed in this booklet.

"B. F. Goodrich Farmer's Handbook and Almanac." 64 pages. This eighteenth edition (1956) of the Almanac contains a variety of articles and useful data of interest to farmers and their families.

"Panarez Hydrocarbon Resins in Shoe Sole Compounds." Pan American Chemicals, New York, N. Y. 10 pages. This bulletin discusses the use and advantages of the company's thermoplastic polymeric plasticizer resins in rubber sole compounding and gives sample GR-S recipes for making sole stock of various grades, as well as physical test data of the stock after curing.

"Lytrons." Bulletin No. 1005. Monsanto Chemical Co., Springfield, Mass. 28 pages. The firm's synthetic polyelectrolyte thickeners for latex and other aqueous dispersion systems are discussed as replacements for natural thickeners. A wide range of technical data is given, including chemical and physical properties, the preparation of solutions, applications, and solvent compatibilities.

"Pliovic DB80V and Pliovic DB90V." Tech-Book Bulletin 55-360. The Goodyear Tire & Rubber Co., chemical division, Akron, O. 2 pages. Properties and applications of these two dry blending Goodyear vinyl resins are included in this data sheet.

"Ampli-Speed Magnetic Drive." Bulletin No. 4400-PRD-229. Electric Machinery Mfg. Co., Minneapolis, Minn. 4 pages. Description, applications, and specifications of the company's drive mechanism for adjusting the speed of both fan-type and constant torque load equipment are contained in this illustrated folder.

"The ISCC-NBS Method of Designating Colors and a Dictionary of Color Names." Kenneth L. Kelly and Deane B. Judd. National Bureau of Standards Circular 533. Government Printing Office, Washington 25, D. C. 158 pages. Price, $2.00. This booklet is designed to assist scientists, and others, in understanding the different color vocabularies used in many fields of science, industry, and art.

"Modern Multiple V-Belt Drives." 20E8297. Allis-Chalmers Mfg. Co., Milwaukee, Wis. 36 pages. Specifications of the company's V-belts, formulae for selecting required belts, and the history of the modern multiple V-belt drive are included in this illustrated booklet.

"Advastab C-77." Bulletin 11155 (revised). Advance Solvents & Chemical Corp., New York, N. Y. 2 pages. The physical properties and uses of Advastab C-77, a cadmium-type vinyl stabilizer which does not contain fatty acids, are included in these data sheets.

"Electrical Engineering Problems in the Rubber and Plastics Industries." T-77. American Institute of Electrical Engineers, New York, N. Y. 160 pages. Price, $3.50. Published here are the papers presented at the seventh AIEE "Conference on Electrical Engineering Problems in the Rubber and Plastics Industries," including "Status of Automation in the Rubber and Plastics Industries" by G. V. Kullgren, Hale & Kullgren, Inc., which was published in the June, 1955, issue of RUBBER WORLD. A report of the conference appeared in our May, 1955, issue.

MARKET REVIEWS

Natural Rubber

Natural rubber prices on both the spot and future markets continued their sharp drop during the period from January 16 to February 15. The #1 grade of R.S.S. fell a total of 4¢ a pound during the period, from a period high of 42¢ on January 16 to 38¢ by February 15. Recorded low for the period was 37.63¢ on February 14. The volume of trading on the New York Commodity Exchange declined with prices.

The behavior of the price structure was in line with economic laws. It was simply a case of less demand for greater available supplies. Tire manufacturers were still cutting back on production and felt no immediate need to strengthen their stockpiles. Other rubber manufacturers were also lowering their production sights in the general belief that the 1955 boom would suffer some setback during 1956. While this curtailed buying was on, available supplies of rubber in the Far East were piling up in warehouses as plantation output reached its annual high. Quantities offered on the foreign cables were heavy, and most went begging for takers.

With the approaching dry season in the Far East and the consequent diminishing of output, *Hevea* prices are expected to strengthen, at least enough to taper off the fall. But no appreciable price climb is anticipated.

Statistically, on the New York Commodity Exchange, sales for the second half of January were 34,310 tons, bringing the monthly total to 58,480 tons. Sales during the first half of February were 29,170 tons, evidence of the waning interest. Sales during the January 16-February 15 period were 63,480 tons. Near-March stocks began the period at 40.40¢ for the #1 grade and were at 36.90¢ on February 15. December stocks began at 34.30¢ and fell to 33.25¢ at period-end.

There were 22 trading days.

COMMODITY EXCHANGE
WEEK-END CLOSING PRICES

Futures 1956	Dec. 23	Jan. 20	Jan. 27	Feb. 3	Feb. 10
Mar.	46.05	40.40	41.70	39.20	37.50
May	42.30	37.37	37.65	36.55	35.85
July	40.40	36.05	36.40	35.10	34.60
Sept.	38.65	34.95	35.40	34.20	33.65
Dec.	36.80	33.80	34.45	33.40	33.05
Total weekly sales, tons	12,570	13,470	12,610	17,820	13,230

On the physical market, January monthly spot prices for representative grades were as follows: R.S.S. #1, 42.69¢; #3 Amber Blankets, 35.00¢; and Flat Bark, 27.73¢. For the first half of February, R.S.S. #1 averaged 39.36¢.

NEW YORK SPOT MARKET
WEEK-END CLOSING PRICES

	Dec. 23	Jan. 20	Jan. 27	Feb. 3	Feb. 10
R.S.S.: #1	48.38	41.13	41.50	40.75	38.63
2	47.38	40.88	41.25	40.50	37.88
3	47.00	40.75	41.13	40.38	37.63
Latex Crepe					
#1 Thick	49.25	44.75	45.00	44.25	41.50
Thin	49.25	44.75	45.00	44.25	41.50
#3 Amber Blankets	36.50	34.38	34.50	33.75	34.13
Thin Brown Crepe	36.00	33.88	34.00	33.25	33.63
Flat Bark	29.13	27.38	27.50	26.75	26.38

Synthetic Rubber

Finally in free and clear possession of the Institute, W. Va., plant, Goodrich-Gulf will go into immediate production of 40,000 tons of "hot" rubber a year, according to William I. Burt, president of the company. Full production of the facilities is not expected for another two years, however, because of the shortage of butadiene. By then the company's butadiene plant at Port Neches, La., should be in full gear.

Mr. Burt also disclosed that Goodrich-Gulf is spending $6,000,000 for a modernization program at Institute that will be spread over a four-year period. This will include the installation of refrigeration for making the much-in-demand "cold" rubber and proper equipment to convert the present batch process to a continuous method for producing the company's Ameripol.

Allaying the fears of some Congressional leaders that small business will be denied access to supplies of synthetic rubber, Mr. Burt said that a major portion of Institute's production will be assigned to small producers. As another mollification of Congress, Attorney General Brownell has even brought the FBI on to the scene. The FBI will survey the small producers to see if they are getting enough rubber for their production needs and will make a report.

So far the output of Institute will have little effect on the market. The one line that will be activated will make only a minor dent in the huge backlog of orders.

Latex

Business in *Hevea* latex improved during the period from January 16 to February 15 as prices dropped sufficiently to induce consumers to buy. Domestic stocks, therefore, were seen to be somewhat stronger than last month's. British observers were optimistic over the situation, believing that the natural latex was now on a more competitive level with the synthetic product and would be used to a greater degree in the manufacture of goods, at least for the present. Supplies of *Hevea* latex at Far Eastern ports, more abundant than they have been in years, were finally being eased in the general market, to the relief of producers there. Despite the improved position of natural latex, demand for synthetic latex was still high.

Prices for ASTM centrifuged concentrated natural latex, in tank-car quantities, f.o.b. rail tank cars, ranged during the period from 43¢ to 48¢ per pound solids. Prices of synthetic latices remained stable, being quoted as GR-S, 26-32.3¢; neoprene, 37-47¢; and N-type, 46-54¢.

Final November and preliminary December domestic statistics for all latices were reported by the United States Department of Commerce as follows:

(All Figures in Long Tons, Dry Weight)

Type of Latex	Production	Imports	Consumption	Month-End Stocks
Natural				
Nov.	0	7,085	6,620	12,616
Dec.	0		6,473	12,645
GR-S Type				
Nov.	6,873	60	5,954	6,307
Dec.	6,352	55	5,719	6,357
Neoprene				
Nov.	1,004	0	829	1,089
Dec.	962	0	768	1,155
Nitrile				
Nov.	781	0	603	1,174
Dec.	874	0	538	1,248

Scrap Rubber

The scrap rubber market during the period from January 16 to February 15 was undistinguished, with activity ranging from quiet to fair. Suppliers filled normal mixed tire orders for Naugatuck, among others, for January and February delivery.

During the period the price of mixed and butyl auto tubes declined fractionally.

Observers reviewing the domestic market in 1955 called it a surprisingly dull affair in view of the general recovery of other scrap materials. Only in synthetic butyl tubes did business improve.

Scrap rubber exports, however, were higher than in 1954, although final figures for 1955 have not yet been released by the Bureau of the Census. For the first 10 months of 1955 scrap rubber exports totaled 30,243,845 pounds, valued at $1,-049,327, compared to the 30,558,059 pounds, valued at $763,228, exported during all of 1954.

Domestic period-end prices follow:

	Eastern Points	Akron, O.
	(Per Net Ton)	
Mixed auto tires	$12.00/16.00	$16.00
S. A. G. auto tires	Nom.	13.00
Truck tires	14.00	/16.00
Peelings, No. 1	41.00/42.00	41.00/42.00
2	23.00	24.00
3	15.50	Nom.
Tire buffing	14.00	14.00/15.00
	(¢ per Lb.)	
Auto tubes, mixed	4.00	/4.00
Black	5.75	5.50
Red	6.75	6.50
Butyl	5.00	/5.00

Reclaimed Rubber

The reclaimed rubber market improved slightly during the period from January 16 to February 15, but business was expected to taper off somewhat until the end of February. Reclaimers generally agree that 1956 would not be so good a year as 1955. Although final figures for 1955 have not yet been made available, it has been estimated that the 1955 business level would be about 20% higher than business during 1954.

The price of butyl reclaim has been reduced ½¢ a pound by one prominent reclaimer; others are expected to follow suit. Other prices remained unchanged during the period.

RECLAIMED RUBBER PRICES

	Lb.
Whole tire: first line	$0.105
Fourth line	.0925
Inner tube: black	.15
Red	.21
Butyl	.155
Pure gum, light colored	.23
Mechanical, light colored	.135

The above list includes those items or classes only that determine the price basis of all derivative reclaim grades. Every manufacturer produces a variety of special reclaims in each general group separately featuring characteristic properties of quality, workability, and gravity at special prices.

Rayon

Final figures released on the rayon and acetate industry during 1955 show that both production and shipments in all phases of the industry enjoyed considerable increases over 1954 business. Total 1955 production came to 1,260,700,000 pounds, an increase of 16% over the 1954 output of 1,085,700,000 pounds. High-tenacity rayon yarn amounted to 432,700,000 pounds, 27½% higher than in 1954; regular and intermediate tenacity rayon yarn, 202,300,000 pounds, 19% higher than in 1954; and acetate yarn, 230,100,000 pounds, 16½% higher than in 1954.

Total shipments of rayon and acetate yarn were 1,261,900,000 pounds, only 0.5% below the all-time record of 1,268,600,000 pounds sold in 1950. This near-record 1955 figure, however, was only 14% greater than in 1954 because 22,200,000 pounds of the 1954 shipments were made from stock. A breakdown of the 1955 shipments shows high-tenacity rayon yarn, 434,300,000 pounds; regular and intermediate tenacity rayon yarn, 206,200,000 pounds; and acetate yarn, 228,000,000 pounds.

The United States continues to be a large net importer of rayon and acetate; the 1955 imports of a record-breaking 172,200,000 pounds represented 11½% of the total available supply in this country.

During 1955 the tire industry received 416,200,000 pounds of rayon and acetate filament yarn in shipments.

As of this writing, another tire yarn producer, E. I. du Pont de Nemours & Co., Inc., has raised its prices 3-5¢ a pound. Two other producers, Industrial Rayon Corp. and North American Rayon Corp., are expected to follow suit, completing the major roster of the industry.

RAYON PRICES

Tire Yarns

High-Tenacity		
1100/ 480	$0.62/	$0.67
1100/ 490	.62/	.67
1150/ 490	.62/	.67
1165/ 480	.63	
1230/ 490	.62	
1650/ 720	.61/	.66
1650/ 980	.61/	.66
1875/ 980	.61	
2200/ 960	.60/	.65
2200/ 980	.60/	.65
2200/1466	.67	
4400/2934	.63	
Super-High-Tenacity		
1650/ 720	.64/	.69
1900/ 720	.64	

Tire Fabrics

1100/490/2	.72	
1650/980/2	.695/	.73
2200/980/2	.685	

Cotton Fabrics

A quiet but firm tone characterized the industrial fabrics market during the period from January 16 to February 15, with the slack in automotive fabrics being offset by moderate to heavy sales in such other items as enameling ducks, wide sateens, belting ducks, and Army ducks. Most of these were heavily booked for delivery in the second quarter.

With the generally slower pace of trading in wide industrial goods, some second-hand offerings also have been coming into the market recently. Prices on most of these second-hand goods, however, have not shown any tendency to soften. Most goods remain quite firm in price, and goods are selling second-hand at little or no concessions.

Some specialty industrial fabrics that originally were made for automotive use may be offered at distressed levels because these goods will not be used for new-car models. Auto manufacturers will be bringing out 1957 models as early as August this year and for this reason are now working on specifications for fabric that will go into these models, trade sources reported. In order to have these fabrics finished, or coated, in sufficient time, it probably will be necessary for coaters to begin buying gray goods early in the second quarter.

The price picture during the period was highlighted by a 2¢ a pound increase in hose and belting ducks, the first advance in these materials in the last 19 months. The rise was attributed to the strong demand for these fabrics by rubber coaters and manufacturers in the conveyor belt field. Most other prices remained steady.

COTTON FABRICS

Drills

59-inch 1.85 yd.	*yd.*	$0.40
2.25-yd.		.34

Ducks

38-inch 1.78-yd. S.F.	*yd.*	nom.
2.00-yd. D.F.		.33
51.5-inch, 1.35-yd. S.F.		nom.
Hose and belting		.69

Osnaburgs

40-inch 2.11-yd.	*yd.*	.265
3.65-yd.		.1675

Raincoat Fabrics

Printcloth, 38½-inch, 64x60, 5.35-yd.	*yd.*	.1425
6.25 yd.		.12
Sheeting, 48-inch, 4.17-yd.		.20
52-inch, 3.85-yd.		.24

Chafer Fabrics

14.40-oz./sq. yd. Pl.	*yd.*	.70
11.65-oz./sq. yd. S.		.61
10.80-oz./sq. yd. S.		.6575
8.9-oz./sq. yd. S.		.67

Other Fabrics

Headlining, 59-inch, 1.65-yd., 2-ply	*yd.*	.465
64-inch, 1.25-yd., 2-ply		.595
Sateens, 53-inch, 1.32-yd.		.5675
58-inch, 1.21-yd.		.62

Financial

(*Continued from page 850*)

Pennsylvania Salt Mfg. Co., Philadelphia, Pa. For 1955: net earnings, $3,484,238, equal to $2.80 a share, against $3,390,901, or $2.73 a share, in 1954.

Pittsburgh Plate Glass Co., Pittsburgh, Pa. For 1955: net income, $61,433,716, equal to $6.26 a share, compared with $38,637,629, or $4.18 a share, a year earlier.

Plymouth Rubber Co., Inc., Canton, O. Year ended November 26, 1955: net profit, $462,905, equal to 51¢ a share, against $422,335, or 47¢ a share, in the preceding fiscal year.

H. K. Porter Co., Inc., Pittsburgh, Pa. For 1955: net income, $6,433,107, equal to $6.15 a share, contrasted with $3,215,785, or $3.06 a share, in 1954.

Raybestos-Manhattan, Inc., Passaic, N. J., and domestic subsidiaries. Year ended December 31, 1955: net earnings, $3,738,496, equal to $5.95 each on 628,100 capital shares, compared with $2,798,094, or $4.45 a share, in 1954; federal income taxes, $3,475,000, against $2,015,000.

Seiberling Rubber Co., Akron, O. Year ended December 31, 1955: net profit, $1,127,085, equal to $2.35 a common share, contrasted with $215,789, or 2¢ a share, the year before; net sales, $45,987,064, against $35,714,299; income taxes, $1,156,542, against $180,143; current assets, $17,385,919, current liabilities, $7,024,233, against $14,831,621 and $4,682,900, respectively, on December 31, 1954.

Shell Oil Co., New York, N. Y., and subsidiaries. For 1955: net income, $125,500,000, equal to $4.56 each on 27,533,076 common shares, compared with $121,127,000, or $4.41 each on 27,480,076 shares, the year before.

Sun Oil Co., Philadelphia, Pa. For 1955: net income, $48,307,360, equal to $4.72 a share, against $40,343,791, or $3.93 a share, the year before.

(*Continued on page 878*)

Synthetic Rubbers and Latices*

Acrylic Types

Hycar 4021	$1.35[c]
4501	.81[c]

Isobutylene Types

Enjay Butyl 035, 150, 215, 217, 218, 325	.23[a]
165, 265, 267, 268, 365	.24[a]
Hycar 2202	.65[c]
Polysar Butyl 100, 200, 300, 400	.245[c]
101	.2775[a]
301	.255[c]
Vistanex	.45[a]

Neoprene

Neoprene Type AC, CG	.55[a]
GN, GN-A	.41[a]
GRT, S	.42[a]
KNR	.75[a]
W	.39[a]
WRT	.45[a]

Latices

Neoprene Latex 571, 842-A	.37[a]
572	.39[a]
601-A	.40[a]
735, 736	.38[a]
950	.47[a]

Nitrile Types

Butaprene NAA	.54[a]
NF	.49[a]
NL	.50[a]
NXM	.58[a]
Chemigum N1NS	.64[b]
N3NS, N5	.58[b]
N6, N7	.50[b]
Hycar 1001, 1041	.58[c]
1002, 1042, 1042	.50[c]
1014, 1312	.60[c]
1411	.62[c]
1432	.59[c]
1441	.64[c]
Paracril AJ	.485[a]
B, BJ, BLT	.50[a]
C	.58[a]
D	.65[a]
1880	.60[a]
Polysar Krynac 800, 802, 803	.50[c]
801	.58[c]

Latices

Butaprene N-300	.46[b]
N-400, N-401	.54[b]

[a] Freight extra.
[b] Minimum freight allowed.
[c] Freight prepaid.
*Prices are per pound carload or tank-car dry weight unless otherwise specified.
†Listed below are the new GR-S type synthetic rubbers and latices trade names and the chief sales offices of their producers or distributors.

ASRC	—American Synthetic Rubber Corp., 500 Fifth Ave., New York 36, N. Y.
Baytown	—United Rubber & Chemical Co., Baytown, Tex. (producer); United Carbon Co., Inc., Charleston 27, W. Va. (distributor).
Butaprene	—Firestone Tire & Rubber Co., Synthetic Rubber Division, 381 Wilbeth Rd., Akron 1, O.
Copo	—Copolymer Rubber & Chemical Corp., P. O. Box 1029, Baton Rouge 1, La.
G-G	—Goodrich-Gulf Chemicals, Inc., 3121 Euclid Ave., Cleveland 15, O.
Naugapol, Naugatex	—Naugatuck Chemical Division, United States Rubber Co., Naugatuck, Conn.
Philprene	—Phillips Chemical Co., Rubber Chemicals Division, 318 Water St., Akron 8, O.
Plioflex	—Goodyear Tire & Rubber Co., Chemical Division, Akron 16, O.
Pliolite Latex	—Goodyear Tire & Rubber Co., Chemical Division. Also distributed by General Latex & Chemical Corp., 666 Main St., Cambridge 39, Mass.
Polysar	—Polymer Corp., Ltd., Sarnia, Ont., Canada (producer); H. Muehlstein & Co., Inc., 60 E. 42nd St., New York 17, N. Y. (distributor).
S-	—Shell Chemical Corp., Synthetic Rubber Sales Division, 30 W. 50th St., New York 20, N. Y.
Synpol	—Texas-U. S. Chemical Co., Port Neches, Tex. (producer); Naugatuck Chemical (distributor).

Chemigum 200	$0.49[b]
235 CHS, 236	.54[b]
245 B, 245 CHS, 246	.46[b]
Hycar 1512, 1552, 1562, 1577	.46[c]
1551, 1561	.54[c]
1571	.59[c]
1572	.51[c]
Nitrex 2612, 2614	.46[a]
2615	.51[a]

Polysulfide Types

Thiokol LP-2, -3, -32, -33	.96[a]
-8, -38	1.25[a]
PR-1	.95[a]
Type-A	.47[a]
FA	.69[a]
ST	1.00[a]

Latices

Thiokol Latex (dry wt.)	
Type MF	.85[a]
MX	.70[a]
WD-2	.92[a]
-5	.95[a]
-6, -7	.70[a]

Silicone Types

GE (compounded)	$2.25[a] /	$4.10[a]
Silicone gum (not compounded)	4.00[a] /	4.90[a]
Silastic (compounded)	1.95[b] /	4.50[b]

Styrene Types†

Hot RS

Butaprene S 1000, 1001, 1004, 1006	.23[a]
1009, 1013	.26[a]
1010	.265[a]
1012	.27[a]
1015	.28[a]
G-G 1001, 1006	.241[c]
Naugapol 1016, 1019	.265[b]
1018	.27[b]
1021	.30[b]
1022	.28[b]
1023	.285[b]
Philprene 1000, 1001, 1006	.25[b]
1009	.255[b]
1018	.27[b]
1019	.265[b]
Plioflex 1000, 1006	.2425[c]
Polysar S, S-50, S-65	.241[c]
SS-250	.30[c]
S-X-371	.255[c]
S-1000, -1001, -1006, -1013	.23[a]
-1002, -1011	.2325[a]
Synpol 1000, 1001, 1006, 1007, 1012, 1061	.2425[b]
1002	.245[b]
1009	.2475[b]
1013	.25[b]

Hot RS Black Masterbatch

S-1100	.185[a]

Cold RS

ASRC-1500, -1502	.241[c]
Butaprene S 1500, 1502	.23[a]
Copo 1500, 1502	.241[c]
G-G 1500, 1501, 1502	.241[c]
Naugapol 1503	.27[b]
1504	.295[b]
Philprene 1500, 1502	.25[b]
1503	.27[b]
Plioflex 1502	.2425[c]
Polysar Krylene	.241[c]
S-1500, -1502	.23[b]
Synpol 1500, 1551	.2425[b]

Cold RS Black Masterbatch

Baytown 1600, 1601, 1602	.185[a]
Philprene 1601	.20[b]
1605	.194[b]
S-1600, -1601, -1602	.185[a]

Cold RS Oil Masterbatch

Butaprene S 1703	.195[a]
1705	.1925[a]
1710	.1775[a]
G-G 1703	.206[c]
1705, 1706	.2035[c]
1707	.191[c]
1709, 1710, 1711, 1712	.1885[c]
Philprene 1703	$0.212[b]
1706	.21[b]
1708	.197[b]
1712	.194[b]
Plioflex 1703	.2075[c]
1710	.19[c]
Polysar Krynol	.20[c]
S-1703	.195[a]
-1705, -1706	.1925[a]
-1707	.18[a]
-1709, -1712	.1775[a]
Synpol 1703	.2075[b]
1707	.1925[b]
1708	.195[b]
1710, 1711	.19[b]

Cold RS Oil-Black Masterbatch

Baytown 1801	.17[a]
Philprene 1803	.18[b]
S-1801	.17[a]

Hot RS Latices

Butaprene S Latex Type 2000, 2001, 2006	.26[a]
2002	.285[a]
2003, 2004	.295[a]
Naugatex 2000, 2001, 2006	.263[a]
2002	.288[a]
2005	.30[a]
S-2000	.2275[a]
-2004	.26[a]

Cold RS Latices

Butaprene S Latex Type 2105	.31[a]
Copo 2101	.28[c]
2102, 2105	.31[c]
X-765	.29[a]
Naugatex 2101	.285[a]
2105	.312[a]
X-767	.323[a]
Pliolite Latex 2101, X765	.30[c]
2104, 2105	.32[c]
S-2101	.225[a]

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Financial

(*Continued from page 876*)

Stauffer Chemical Co., New York, N. Y. Year ended December 31, 1955: net earnings, $12,305,000, equal to $4.04 each on 3,048,278 capital shares, compared with $9,210,000, or $3.02 a share, in 1954; sales, $145,490,000, against $116,916,000.

Struthers Wells Corp., Warren, Pa. Year ended November 30, 1955: net earnings, $240,693, equal to 50¢ a share, contrasted with $1,176,991, or $3.93 a share, in the preceding fiscal year; net sales, $15,042,645, against $19,306,385.

Union Carbide & Carbon Corp., New York, N. Y., and subsidiaries. Year ended December 31, 1955: net earnings, $140,755,858, equal to $4.83 a share, compared with $89,779,271, or $3.10 a share, in 1954; sales, $1,187,153,197, against $923,693,379; provision for federal income taxes and renegotiation, $141,827,061, against $82,349,987; current assets, $677,219,203, current liabilities, $229,098,541, against $553,594,053 and $156,946,120, respectively, on December 31, 1954.

United Carbon Co., Charleston, W. Va. For 1955: net profit, $5,560,201, equal to $4.66 each on 1,193,655 capital shares, compared with $4,656,769, or $3.90 a share, the year before; net sales, $50,087,818, against $34,401,333.

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Compounding Ingredients*

Abrasives

Pumicestone, powdered	lb.	$0.0363	$0.065
Rottenstone, domestic	lb.	.03	.04
Shelblast	ton	80.00	165.00
Walnut Shell Grits	ton	50.00	160.00

Accelerators

A-1 (Thiocarbanilide)	lb.	.50	.57
A-32	lb.	.66	.80
A-100	lb.	.52	.66
Accelerator 49	lb.	.55	.56
108	lb.	.90	
552	lb.	2.25	
808	lb.	.66	.68
833	lb.	1.17	1.19
Altax	lb.	.50	.52
Arazate	lb.	2.25	
Beutene	lb.	.66	.71
Bismate	lb.	3.00	
B-J-F	lb.	.27	.32
Butasan	lb.	1.04	
Butazate	lb.	1.04	
Butyl Accelerator 21	lb.	.89	
Eight	lb.	1.10	1.35
Zimate	lb.	1.04	
Captax	lb.	.40	.42
C-P-B	lb.	1.95	
Cumate	lb.	1.45	
Diesterex N	lb.	.50	.57
DOTG (diorthotolylguanidine)			
Cyanamid	lb.	.60	.61
Du Pont	lb.	.57	.58
DPG (diphenylguanidine)			
Cyanamid	lb.	.50	.51
Monsanto	lb.	.48	.55
El-Sixty	lb.	.58	.65
Ethasan	lb.	1.04	
Ethazate	lb.	1.04	
50-D	lb.	.85	
Ethyl Thiurad	lb.	1.04	
Tuads	lb.	1.04	
Tuex	lb.	1.04	
Zimate	lb.	1.04	
Ethylac	lb.	.93	.95
Hepteen	lb.	.44	.50
Base	lb.	1.85	
Ledate	lb.	1.04	
MBT (2-mercaptobenzothiazole)			
American Cyanamid	lb.	.40	.42
Du Pont	lb.	.38	.40
Naugatuck	lb.	.40	.45
-XXX, Cyanamid	lb.	.51	.53
MBTS (mercaptobenzothiazyl disulfide)			
Cyanamid	lb.	.50	.52
Du Pont	lb.	.48	.50
Naugatuck	lb.	.50	.55
-W Cyanamid	lb.	.53	.55
Mertax	lb.	.51	.58
Methasan	lb.	1.04	
Methazate	lb.	1.04	
Methyl Tuads	lb.	1.14	
Zimate	lb.	1.04	
Monex	lb.	1.14	
Mono-Thiurad	lb.	1.14	
Morfex	lb.	.65	.70
MT	lb.	1.00	
NOBS No. 1	lb.	.72	.74
Special	lb.	.77	.79
O-X-A-F	lb.	.51	.56
Pentex	lb.	1.04	
Flour	lb.	.21	
Permalux	lb.	2.17	
Phenex	lb.	.52	.59
Pip-Pip		2.07	
R-2 Crystals	lb.	4.35	
Rotax	lb.	.51	.53
RZ-50, -50B	lb.	1.00	
S. A. 52	lb.	1.14	
57, 62, 67, 77	lb.	1.04	
66	lb.	2.50	
Santocure	lb.	.72	.79
NS	lb.	.78	.85
Selenacs	lb.	4.25	
SPDX-GH	lb.	.69	.74
GL	lb.	1.20	1.34
Tellurac	lb.	1.21	
Tepidone	lb.	.45	
Tetrone A	lb.	1.91	
Thiofide	lb.	.50	.57
S	lb.	.52	.59
Thionex	lb.	1.14	
Thiotax	lb.	.40	.47
Thiurad	lb.	1.14	
Thiuram E	lb.	1.04	
M	lb.	1.14	
Trimene	lb.	.56	.62
Base	lb.	1.03	1.10
Tuex	lb.	1.14	
Ultex	lb.	1.00	1.10
Unads	lb.	1.14	
Ureka Base	lb.	.66	.73
Vulcacure NB	lb.	.45	
ZB, ZE, ZM	lb.	.85	
Vulcacure Z-B-X		$2.45	
Zenite	lb.	.48	$0.50
A	lb.	.49	.51
Special	lb.	.49	.51
Zetax	lb.	.51	.53
Zimate	lb.	1.04	

* Prices, in general, are f.o.b. works. Range indicates grade or quantity variations. No guarantee of these prices is made. Spot prices should be obtained from individual suppliers.

† For trade names, see Color—White, Zinc Oxides.

‡ At the request of the suppliers, the lowest prices shown for carbon blacks are for carloads in bags. Prices for hopper carloads are lower.

Accelerator-Activators, Inorganic

Lime, hydrated	ton	20.21	
Litharge, comml.	lb.	.175	.18
Eagle, sublimed	lb.	.18	
National Lead, sublimed	lb.	.18	.19
Red lead, comml.	lb.	.185	.195
Eagle	lb.	.19	
National Lead	lb.	.19	.20
White lead, carbonate	lb.	.19	.20
Eagle	lb.	.19	.20
National Lead	lb.	.18	.19
Silicate	lb.	.1725	.1825
Eagle	lb.	.20	.2175
National Lead	lb.	.1625	.1725
Zinc oxide, comml.†	lb.	.145	.1925

Accelerator-Activators, Organic

Aktone	lb.	.2125	.2325
Barak	lb.	.62	
Capital 170	lb.	.2175	.2575
171	lb.	.1325	.1725
700, 701	lb.	.16	.20
705, 710	lb.	.16	.20
800	lb.	.12	.14
801	lb.	.1425	.1625
802	lb.	.1475	.1675
803	lb.	.17	.19
Curade	lb.	.57	.59
D-B-A	lb.	1.95	
Emery 600	lb.	.1325	.1725
Groco 30	lb.	.1325	.1725
35	lb.	.1375	.1775
Guantal	lb.	.57	.64
Hyfac 400	lb.	.1138	.14
430	lb.	.1563	.1825
431	lb.	.1788	.205
Hystrene S-97	lb.	.1863	.2125
T-45	lb.	.1638	.19
T-70	lb.	.1738	.20
Industrene B	lb.	.1263	.1525
R	lb.	.1138	.14
158	lb.	.1313	.1575
254	lb.	.1413	.1675
262	lb.	.1513	.1775
Laurex	lb.	.33	.37
MODX	lb.	.295	.345
NA-22	lb.	1.50	
Oleic acid, comml.	lb.	.16	.22
Emersol 210 Elaine	lb.	.16	.20
Groco 2, 4, 8, 18	lb.	.16	.20
Plastone	lb.	.27	.30
Polyvac	lb.	1.65	
Ridacto	lb.	.25	.26
Seedine	lb.	.1485	.1703
Stearex Beads	lb.	.1488	.1588
Stearic acid			
Emersol 120	lb.	.1413	.1675
150	lb.	.1738	.20
Hydrofol 51	lb.	.09	
Hydrogenated, rubber grd.			
Groco	lb.	.12	.14
Rufat 75	lb.	.1138	.14
Single pressed, comml.	lb.	.1425	.1625
Emersol 110	lb.	.1363	.1625
Groco 53	lb.	.1425	.1625
Wilmar 253	lb.	.1363	.1625
Double pressed, comml.	lb.	.1475	.1675
Groco 54	lb.	.1475	.1675
Wilmar 254	lb.	.1413	.1675
Triple pressed, comml.	lb.	.17	.19
Groco 55	lb.	.17	.19
Wilmar 255	lb.	.1638	.19
Sterene 60-R	lb.	.09	.1075
Tonox	lb.	.515	.605
Vulklor	lb.	.88	1.08
Wilmar 110	lb.	.16	.20
434	lb.	.1325	.1725
Zinc stearate, comml.	lb.	.39	.44

Antioxidants

AgeBest A26	lb.	.18	.24
620-32B	lb.	.20	.26
716-30	lb.	.18	.24
1041-21	lb.	.165	.225
1293-22A	lb.	1.90	2.00
AgeRite Alba	lb.	2.35	2.45
Gel	lb.	.64	.66
H. P.	lb.	.72	.74
Hipar	lb.	.98	1.00
Powder	lb.	.52	.54
Resin	lb.	.75	.77
D	lb.	.52	.54
Spar	lb.	.52	.54
Stalite	lb.	.52	.54
S	lb.	.52	.54
White	lb.	1.45	1.55
Akroflex C	lb.	.77	.79
CD	lb.	.72	.74
Albasan	lb.	.69	.73
Allied AA-1144	lb.	.23	.24
AA-1177	lb.	.155	.165
Aminox	lb.	.52	.57
Antioxidant 425	lb.	2.47	2.50
2246	lb.	1.50	1.53
Antisol	lb.	$0.23	$0.24
Antisun	lb.	.15	.51
Antox	lb.	.52	.75
Aranox	lb.	3.25	.54
Betanox Special	lb.	.80	.85
B-L-E, -25	lb.	.52	.57
Burgess Antisun Wax	lb.	.185	
B-X-A	lb.	.52	.57
Copper Inhibiter X-872-L	lb.	2.01	
D-B-P-C	lb.	.91	1.16
Flectol H	lb.	.52	.59
Flexamine	lb.	.72	.77
Heliozone	lb.	.26	.27
Ionol	lb.	.91	1.40
NBC	lb.	1.55	
Neozone A	lb.	.56	.58
D	lb.	.52	.54
Octamine	lb.	.52	.57
PDA-10	lb.	.46	.48
Perflectol	lb.	.61	.68
Polygard	lb.	.52	.57
Protector	lb.	.26	.31
Rio Resin	lb.	.60	.62
Santoflex 35	lb.	.72	.79
75	lb.	.92	.99
AW	lb.	.78	.85
B	lb.	.52	.59
BX	lb.	.63	.70
DD	lb.	.52	.59
Santovar A	lb.	1.50	1.57
Santowhite Crystals, Powder	lb.	1.60	1.67
L	lb.	.52	.59
MK	lb.	1.29	1.36
Sharples Wax	lb.	.23	.28
Stabilite	lb.	.55	.59
Alba	lb.	.72	.79
L	lb.	.60	.64
White	lb.	.52	.60
Powder	lb.	.41	.47
Styphen I	lb.	.51	.55
Sunolite #100	lb.	.21	.23
#127	lb.	.17	.19
Sunproof -713	lb.	.25	.30
Improved	lb.	.25	.30
Jr.	lb.	.20	.25
Thermoflex A	lb.	.98	1.00
Tonox	lb.	.52	.57
Tysonite	lb.	.24	.2475
Velvapex 51-250	lb.	.40	
V-G-B	lb.	.70	.70
Wing-Stay S	lb.	.52	.61
Zenite	lb.	.48	.55

Antiseptics

Copper naphthenate, 6–8%	lb.	.24	
Pentachlorophenol	lb.	.21	.29
Resorcinol, technical	lb.	.775	.785
Zinc naphthenate, 8-10%	lb.	.245	.30

Blowing Agents

Ammonium bicarbonate	lb.	.065	.085
Carbonate	lb.	.16	
Blowing Agent CP-975	lb.	.35	
Celogen	lb.	1.95	
50-C	lb.	1.01	1.07
Sodium bicarbonate	100 lbs.	2.80	3.15
Carbonate, tech.	100 lbs.	1.35	5.52
Sponge Paste	lb.	.20	
Unicel	lb.	.90	
ND	lb.	.76	
S	lb.	.20	

Bonding Agents

Braze	gal.	6.00	9.00
Cover cement	gal.	2.50	4.00
Flocking Adhesive RFA17, RFA22, RFA25	gal.	.50	
G-E Silicone Paste SS-15	lb.	4.52	5.10
SS-64	lb.	3.65	6.75
-67 Primer	lb.	7.50	12.50
Gen-Tac Latex	lb.	.75	.855
Kalabond Adhesive	gal.	6.50	16.00
Tie Cement	gal.	2.00	5.60
MDI	lb.	4.00	6.00
-50	lb.	2.00	3.00
Thixons	gal.	1.48	12.00
Ty Ply BN, Q, S, UP, 3640	gal.	6.75	8.00
RC	gal.	3.75	5.00

Brake Lining Saturants

BRT 3	lb.	.018	.0265
Resinex L-S	lb.	.0225	.03

Carbon Blacks‡

Conductive Channel—CC

Continental R-40	lb.	.23	.30
Kosmos/Dixie BB	lb.	.23	.30
Spheron C	lb.	.15	.195
Voltex	lb.	.18	.315

Easy Processing Channel—EPC

Continental AA	lb.	.074	.1225
Kosmobile 77/Dixiedensed 77	lb.	.074	.1225
Micronex W-6	lb.	.074	.1225
Spheron #9	lb.	.074	.1225
Texas E	lb.	.074	.1225
Witco #12	lb.	.074	.1225
Wyex EPC	lb.	.074	.1225

Hard Processing Channel—HPC

Continental F	lb.	.074	.1225
HX HPC	lb.	.074	.1225
Kosmobile S/Dixiedensed S	lb.	.074	.1225

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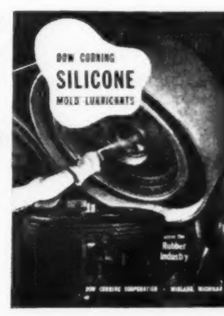

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CANADA: DOW CORNING SILICONES LTD., TORONTO GREAT BRITAIN: MIDLAND SILICONES LTD., LONDON FRANCE: ST. GOBAIN, PARIS

Micromex Mk. II	lb.	$0.074 /	$0.1225
Witco #6	lb.	.074 /	.1225

Medium Processing Channel—MPC

Arrow MPC	lb.	.074 /	.1225
Continental A	lb.	.074 /	.1225
Kosmobile S-66/Dixiedensed			
S-66	lb.	.074 /	.1225
Micronex Standard	lb.	.074 /	.1225
Spheron #6	lb.	.074 /	.1225
Texas 109	lb.	.079 /	.1275
M	lb.	.074 /	.1225
Witco #1	lb.	.074 /	.1225

Conductive Furnace—CF

Aromex CF	lb.	.089 /	.129
Vulcan C	lb.	.105 /	.15
SC	lb.	.18 /	.223

Fast Extruding Furnace—FEF

Arovel FEF	lb.	.06 /	.10
Continex FEF	lb.	.06 /	.10
Kosmos 50/Dixie 50	lb.	.06 /	.10
Statex M	lb.	.06 /	.10
Sterling SO	lb.	.06 /	.10

Fine Furnace—FF

Statex B	lb.	.065 /	.105
Sterling 99	lb.	.065 /	.105

High Abrasion Furnace—HAF

Aromex	lb.	.079 /	.119
Continex HAF	lb.	.079 /	.125
Kosmos 60/Dixie 60	lb.	.079 /	.1175
Philblack O	lb.	.074 /	.114
Statex R	lb.	.074 /	.12
Vulcan #3	lb.	.074 /	.114

Intermediate Super Abrasion Furnace—ISAF

Aromex 125	lb.	.10 /	.14
Kosmos 70/Dixie 70	lb.	.10 /	.145
Philblack I	lb.	.09 /	.13
Statex 125	lb.	.09 /	.135
Vulcan 6	lb.	.09 /	.13

Medium Abrasion Furnace—MAF

Philblack A	lb.	.06 /	.10

Super Abrasion Furnace—SAF

Philblack E	lb.	.125 /	.165
Vulcan 9	lb.	.125 /	.165

General-Purpose Furnace—GPF

Arogen GPF	lb.	.05 /	.09
Sterling V	lb.	.05 /	.09
V Non-staining	lb.	.05 /	.09

High Modulus Furnace—HMF

Continex HMF	lb.	.055 /	.095
Kosmos 40/Dixie 40	lb.	.055 /	.095
Modulex HMF	lb.	.055 /	.095
Statex 93	lb.	.055 /	.095
930	lb.	.047 /	.087
Sterling L, LL	lb.	.055 /	.095

Semi-Reinforcing Furnace—SRF

Continex SRF	lb.	.045 /	.085
Essex SRF	lb.	.0475/	.0875
Furnex	lb.	.0475/	.0875
Gastex	lb.	.0525/	.0925
Kosmos 20/Dixie 20	lb.	.045 /	.085
Pelletex, NS	lb.	.0475/	.0875
Sterling NS, S	lb.	.0475/	.0875
R	lb.	.0525/	.0925

Fine Thermal—FT

P-33	lb.	.055	
Sterling FT	lb.	.055	

Medium Thermal—MT

Sterling MT	lb.	.04	
Non-staining	lb.	.05	
Thermax	lb.	.04	
Stainless	lb.	.05	

Colors

Black

Iron oxides, comml.	lb.	.1325/	.135
BK—Lansco	lb.	.1275/	.13
Williams	lb.	.1425/	.145
Lansco synthetic	lb.	.10	
Mapico	lb.	.1425/	.145
Lampblack, comml.	lb.	.16 /	.45
Superjet	lb.	.0825/	.1175
Permanent Blue	lb.	.80 /	1.05
Stan-Tone	lb.	.45 /	1.20
Vansul masterbatch	lb.	.60 /	.65
Paste	lb.	.14 /	.15

Blue

Alkali Blue	lb.	1.12 /	2.10
Cyanamid ultramarine	lb.	.29	
Du Pont	lb.	1.77 /	4.55
Filo	lb.	.28	
Heveatex pastes	lb.	.80 /	1.45
Lansco ultramarines	lb.	.25 /	.28
Monsanto Blue 7	lb.	1.55	
11	lb.	3.45	
DPB-283	lb.	1.93	
S-11	lb.	2.05	
Permanent Blue	lb.	.80 /	1.05
Stan-Tone	lb.	1.55 /	1.60
Vansul masterbatch	lb.	.90 /	2.70

Brown

Filo	lb.	$0.13	
Iron oxides, comml.	lb.	.1425/	$0.145
Lansco synthetic	lb.	.125	
Mapico Brown	lb.	.1525/	.155
Sienna, burnt, comml.	lb.	.0425/	.155
Williams	lb.	.115 /	.1775
Raw, comml.	lb.	.045 /	.1325
Williams	lb.	.08 /	.1725
Umber, burnt, comml.	lb.	.06 /	.07
Williams	lb.	.0725/	.085
Raw, comml.	lb.	.0625/	.07
Williams	lb.	.07 /	.0825
Williams, pure brown	lb.	.1525/	.155
Vandyke	lb.	.12	
Mapico Tan 20	lb.	.2025/	.205
Tan 15	lb.	.205	
Metallic brown	lb.	.0475/	.0575
Vansul masterbatch	lb.	2.10 /	2.20

Green

Chrome	lb.	.19 /	.50
Oxide	lb.	.3925/	1.10
Cyanamid	lb.	1.10	
G-4099, -6099	lb.	.42	
GH-9869	lb.	1.05 /	1.20
9976	lb.	1.15 /	1.30
Green	lb.	.80 /	2.40
Du Pont	lb.	1.97 /	2.80
Filo	lb.	.40	
Heveatex pastes	lb.	.95 /	1.85
Lansco Toner	lb.	1.35	
Monsanto Green 3	lb.	2.75	
14	lb.	1.45	
17	lb.	3.95	
71205	lb.	1.35	
DGP	lb.	2.03	
S-17	lb.	2.25	
Stan-Tone	lb.	1.75 /	4.60
Vansul masterbatch	lb.	2.00 /	2.60

Orange

Cyanamid Permatons	lb.	1.35	
Du Pont	lb.	2.75	
Monsanto Orange 68187	lb.	2.90	
Stan-Tone	lb.	.70 /	3.35
Vansul masterbatch	lb.	2.00 /	2.60

Red

Antimony trisulfide	lb.	.285 /	.315
R. M. P. No. 3	lb.	.72	
Sulfur Free	lb.	.78	
Cadmium red lithopones	lb.	2.21 /	3.77
Cadmolith	lb.	1.72 /	2.20
Cyanamid	lb.	.85 /	1.60
Du Pont	lb.	1.47 /	1.80
Filo	lb.	.11	
Indian Red	lb.	.1275	
Iron oxide, comml.	lb.	.06 /	.13
Lansco synthetic	lb.	.1175	
Mapico	lb.	.1375/	.14
Recco	lb.	.12	
Williams Red	lb.	.13 /	.1525
Monsanto Maroon 113	lb.	1.50	
61148	lb.	1.75	
Red 7	lb.	1.55	
41	lb.	4.40	
3501	lb.	1.15	
4004	lb.	1.50	
69191	lb.	3.38	
Autumn	lb.	1.10	
PRP-285	lb.	1.27	
S-44	lb.	1.28	
Rub-Er-Red	lb.	.0975	
Stan-Tone	lb.	.85 /	4.05
Tuscan	lb.	.15 /	.46
Vansul masterbatch	lb.	.95 /	3.30
Venetian	lb.	.04 /	.0675

White

Antimony oxide	lb.	.29 /	.305
Burgess Iceberg	ton	50.00 /	80.00
Cryptone BT	lb.	.10 /	.11
Permolith	lb.	.075 /	.085
Titanium pigments			
Rayox LW	lb.	.195 /	.205
R-110	lb.	.215 /	.225
Ti-Cal	lb.	.075 /	.0825
Ti-Pure	lb.	.195 /	.225
Titanox A, AA, A-168	lb.	.21 /	.22
C-50	lb.	.1225 /	.1275
RA, -10, -50	lb.	.23 /	.24
RC	lb.	.0825 /	.0875
-HT, -HTX	lb.	.08 /	.085
Unitane	lb.	.245 /	.275
Zopaque Anatase	lb.	.225 /	.235
Rutile	lb.	.245 /	.255
Zinc oxide, comml.	lb.	.135 /	.1775
Azo ZZZ-11, -44, -55	lb.	.145 /	.165
20% leaded	lb.	.1505 /	.1705
35% leaded	lb.	.155 /	.175
50% leaded	lb.	.1588 /	.1788
Eagle AAA, lead free	lb.	.145 /	.155
5% leaded	lb.	.145 /	.155
35% leaded	lb.	.155 /	.165
50% leaded	lb.	.159 /	.169
Florence Green Seal	lb.	.1575 /	.1675
Red Seal	lb.	.1525 /	.1625
White Seal	lb.	.1625 /	.1725
Horsehead XX-4, -78	lb.	.135 /	.145
Kadox-15, -17, -72, -515	lb.	.14 /	.15
-25	lb.	.1625 /	.1725
Lehigh, 35% leaded	lb.	.155 /	.175
50% leaded	lb.	.1586 /	.1788
Protox-166, -167	lb.	.145 /	.165
St. Joe, lead free	lb.	.122 /	.152
Zinc sulfide, comml.	lb.	.253 /	.263
Cryptone ZS	lb.	.253 /	.273

Yellow

Cadmium yellow lithopones	lb.	1.12 /	$1.15
Cadmolith	lb.	1.12 /	1.20
Cyanamid Hansa Yellow	lb.	2.10	
Du Pont	lb.	1.80 /	2.15
Filo	lb.	.10	
Iron oxide, comml.	lb.	.0525/	.1175
Lansco synthetic	lb.	.1075	
Mapico	lb.	.115 /	.1225
Williams	lb.	.115 /	.1225
Monsanto Yellow 14	lb	1.91	
10010	lb.	1.91	
BYP-282	lb.	1.21	
GA	lb.	2.45	
S-10010	lb.	1.17	
Stan-Tone	lb.	1.00 /	1.55
Vansul masterbatch	lb.	.95 /	1.95
Williams Ocher	lb.	.0575/	.06

Dusting Agents

Diatomaceous silica	ton	32.00 /	48.00
Extrud-o-Lube, conc.	gal.	1.54 /	1.69
Glycerized Liquid Lubricant, concentrated	gal.	1.48 /	1.63
Latex-Lube GR	lb.	.20	
Pigmented	lb.	.1825	
R-66	lb.	.165	
Liqui-Lube	lb.	.1625	
N. T.	lb.	.1675	
Liquizinc No. 305	lb.	.30 /	.35
Lubrex	lb.	.25 /	.30
Mica Concord	lb.	.075 /	.0825
Mineralite	ton	45.00	
Pyrax A	ton	13.50	
W. A.	ton	16.00	
Talc, comml.	ton	18.40 /	38.50
EM	ton	11.00 /	63.00
LS Silver	ton	29.25	
Nytals	ton	25.00 /	36.00
Sierra Sagger 7	ton	34.00	
White IR	ton	19.75	
III	ton	20.75	
Vanfre	gal.	2.00 /	

Extenders

BRS 700	lb.	.02 /	.0285
BRT 7	lb.	.03 /	.031
Cumar Resins	lb.	.065 /	.17
Dielex B	lb.	.06	
Factice, Amberex	lb.	.29 /	.36
Brown	lb.	.1425/	.268
Neophax	lb.	.157 /	.268
White	lb.	.144 /	.285
G. B. Asphaltenes	lb.	.06 /	.065
Millex, W	lb.	.07	
Mineral Rubbers			
Black Diamond	ton	38.00 /	40.00
Hard Hydrocarbon	ton	46.50 /	48.50
Hydrocarbon MR	ton	45.00 /	55.00
Parmr	ton	21.00 /	29.00
T-MR Granulated	ton	47.50 /	50.00
Nuba No. 1, 2	lb.	.0575/	.0625
3X	lb.	.0775/	.0825
OPD-101	lb.	.26	
Rubber substitute, brown	lb.	.1835/	.2013
Car-Bel-Ex A	lb.	.14	
Car-Bel-Lite	lb.	.35	
Extender 600	lb.	.1765	
White	lb.	.148 /	.256
Stan-Shells	ton	35.00 /	73.00
Sublac Resin PX-5	lb.	.215 /	.235
Synthetic 100	lb.	.41	
Vistanex	lb.	.35 /	.475

Fillers, Inert

Agrashell flour	ton	50.00 /	74.00
Barytes, floated, white	ton	41.60 /	60.10
Off-color, domestic	ton	25.00	
No. 1	ton	41.35 /	60.10
2	ton	39.35 /	58.00
Sparmite	ton	75.00 /	80.00
Blanc fixe	ton	100.00 /	165.00
Burgess Iceberg	ton	50.00 /	80.00
Pigment #20	ton	35.00 /	60.00
#30	ton	37.00 /	60.00
HC-75	ton	12.00 /	30.00
-80	ton	14.00 /	32.00
WP #1	ton	11.00 /	16.00
Cary #200	ton	30.00 /	55.00
Citrus seed meal	lb.	.04	
Oil	lb.	.15	
Clays, Aiken	ton	14.00	
Albacar	ton	50.00 /	55.00
Aluminum Flake	ton	20.00 /	60.00
#5	ton	23.50 /	30.00
Champion	ton	14.00	
Crown	ton	14.00 /	33.00
Dixie	ton	14.00	
Franklin	ton	13.50 /	35.25
GK Soft Clay	ton	11.00	
Hi-White R	ton	13.50	
Hydratex R	ton	28.00	
Kaolloid	ton	10.50	
Paragon	ton	13.50 /	31.50
McNamee	ton	13.50	
RX-43	ton	33.00	
Recco	ton	14.00	
Sno-Brite	ton	12.50	
Stan-Clay	ton	28.00	
Stellar-R	ton	50.00	
Suprex	ton	14.00 /	32.00
Swanee	ton	12.50	
Windsor	ton	14.00 /	30.00
DC Silica	lb.	1.45 /	1.65
Diatomaceous silica	ton	32.00 /	48.00

Flocks			
Cotton, dark	lb.	$0.095 /	$0.135
Dyed	lb.	.55 /	.60
White	lb.	.13 /	.33
Fabrifil X-24-G	lb.	.135	
X-24-W	lb.	.235	
Filfloc 6000	lb.	.33	
F-40-900	lb.	.135	
HSC #35 Silicone Emulsion	lb.	1.28 /	2.50
Kalite	ton	50.00 /	65.00
Lithopone, comml.	lb.	.075 /	.085
Albalith	lb.	.075 /	.085
Astrolith	lb.	.06¾ /	.0675
Eagle	lb.	.0725 /	.075
Sunolith	lb.	.075 /	.0825
Mica Concord	lb.	.075 /	.0825
Millical	ton	38.00 /	53.00
Mineralite	ton	40.00 /	60.00
Non-Fer-Al	ton	32.50 /	47.50
Purecal	ton	56.75 /	71.75
Pyrax A	ton	13.50	
W. A.	ton	16.00	
Sawdust	ton	14.00 /	35.00
StanWhite	ton	10.50 /	13.10
Super-White Silica	ton	23.00 /	43.00
Surfex	ton	37.50 /	52.50
MM	ton	39.50 /	54.50
Suspenso	ton	35.50 /	50.50
Ti-Cal	lb.	.0675	
Valron estersil	lb.	1.00	
Whiting, limestone			
Atomite	ton	30.00	
Calcite	ton	23.00	
Keystone	ton	16.00	
Laminar	ton	30.00	
Omya	ton	30.00	
Paxinosa	ton	11.00 /	19.00
Snowflake	ton	17.00 /	18.00
Stonelite	ton	9.00	
Witco	ton	8.50	
York	ton	9.50	

Finishes

Apex Bright Finish #5200-E	lb.	.25	
Rubber Finish	gal.	2.50	
Black-out	gal.	4.50 /	8.00
Flocks, Rayon, colored	lb.	.90 /	1.50
White	lb.	.75 /	1.25
Also see Flocks, under Fillers, Inert			
Rubber lacquer, clear	gal.	1.00 /	2.00
Shellacs, Angelo	lb.	.485 /	.7325
Vac Dry	lb.	.485 /	.57
Talc (*See Talc, under Dusting Agents*)			
Unidip	lb.	.15 /	.20
Wax, Bees	lb.	.68 /	.83
Carnauba	lb.	.57 /	1.13
Montan	lb.	.27	
No. 118, colors	gal.	.86 /	1.41
Neutral	gal.	.76 /	1.31
Van Wax	gal.	1.45 /	1.50

Latex Compounding Ingredients

Acintol D, DLR	lb.	.06 /	.075
FA #1	lb.	.065 /	.08
#2	lb.	.075 /	.09
Accelerator 552	lb.	2.25	
J-117, -302	lb.	1.00 /	1.15
-144	lb.	.15 /	.30
-307	lb.	1.10 /	1.25
-311	lb.	.60 /	.75
Aerosol, dry types	lb.	.39 /	1.20
Liquid types	lb.	.40 /	.72
Alcogum AN-6	lb.	.05	
AN-10	lb.	.085	
Alrosol	lb.	.41	
Alrowet D-75	lb.	.63	
Amberex solutions	lb.	.1675/	.18
Antifoam J-114	lb.	3.25 /	3.45
P-242	lb.	.24 /	.35
Antioxidant J-137, -140	lb.	.55 /	.70
-139, -293	lb.	1.45 /	1.60
-182	lb.	2.00 /	2.15
-186	lb.	1.40 /	1.55
2246	lb.	1.50 /	1.53
Anti Webbing Agent J-183	lb.	.75 /	.90
-297	lb.	.27 /	.40
Aquablak B	lb.	.0925/	.0975
G	lb.	.105 /	.11
K	lb.	.1075/	.1125
M	lb.	.085 /	.09
Aquarex D	lb.	.78	
G	lb.	.21	
L. ME	lb.	.94	
MDL	lb.	.33	
NS	lb.	.60	
SMO	lb.	.50	
WAQ	lb.	.23	
Areskap 50	lb.	.30 /	.38
100, dry	lb.	.60 /	.72
Aresket 240	lb.	.30 /	.38
300, dry	lb.	.60 /	.72
Aresklene 375	lb.	.42 /	.57
Ben-A-Gels	lb.	.98 /	1.40
Bentone 18, 18C	lb.	.45	
34	lb.	.60	
Casein	lb.	.22	
Cellosize WP-09, -3, -300	lb.	1.36 /	1.60
CW-12	lb.	.85	
37	lb.	.70	
DC Antifoam A Compound	lb.	5.45 /	6.65
Emulsion	lb.	2.05 /	4.00
AF Emulsion	lb.	2.05 /	2.85
Compound 7	lb.	5.13 /	6.50
Defoama W-1701	lb.	.125	
Defoamer 115a	lb.	.50	

Dispersing Agents			
Blancol	lb.	$0.1525/	$0.26
N	lb.	.155 /	.26
Darvan Nos. 1, 2, 3	lb.	.22 /	.30
Daxad 11, 21, 23, 27	lb.	.08 /	.30
Dispersaid H7A	lb.	.58	
1159	lb.	.43	
Empulphor ON-870	lb.	.50 /	.70
Igepal CO-630	lb.	.2875/	.47
Igepon T-73	lb.	.285 /	.495
T-77	lb.	.45 /	.69
Indulins	lb.	.06 /	.08
Kreelons	lb.	.132 /	.155
Laurelton Oil	lb.	.18	
Leonil SA	lb.	.52 /	.65
Lomar PW	lb.	.18	
Marasperse CB	lb.	.1225/	.1425
N	lb.	.095 /	.105
Modicols	lb.	.17 /	.58
Nekal BA-75	lb.	.395 /	.54
BX-76	lb.	.63 /	.75
Pluronics	lb.	.335 /	.40
Polyfons	lb.	.08 /	.09
Sorapon SF-78	lb.	.28 /	.40
Tergitol NPX	lb.	.275 /	.3074
TMN	lb.	.2875/	.32
7	lb.	.4125/	.44
Trenamine	lb.	.15	
Triton R-100	lb.	.12 /	.25
X-100, -102, -114	lb.	.255 /	.36
Dispersions			
AgeRite Alba	lb.	3.00	
Powder, Resin D	lb.	.80	
White	lb.	1.80	
Altax	lb.	.75	
Black No. 25	lb.	.22	
Shield Nos. 2, 6	lb.	.08	
3	lb.	.095	
4-35	lb.	.09	
5	lb.	.093	
7-F, 8	lb.	.165	
55	lb.	.18	
Iron Oxide, 60%	lb.	.40	
L.S.W.	lb.	1.50	
No. 305 Liquizinc	lb.	.30 /	.35
P-33	lb.	.35	
Rayox	lb.	.45	
Rotax	lb.	.75	
Sulfur	lb.	.12 /	.30
No. 2	lb.	.14 /	.16
Telloy	lb.	3.00	
Tuads, Methyl	lb.	1.60	
Vulcanizing, C group	lb.	.40 /	1.30
G group	lb.	.45 /	.90
N group	lb.	.40 /	1.00
Zetax	lb.	.75	
Zimates, Butyl	lb.	1.30	
Ethyl, Methyl	lb.	1.35	
Zinc oxide	lb.	.40	
Emulsions			
AgeRite Stalite	lb.	.75	
Habuco Resin Nos. 502, 515, 523	lb.	.195 /	.20
503	lb.	.22 /	.225
504, 526	lb.	.19 /	.195
517	lb.	.175 /	.18
524	lb.	.155 /	.16
Resin A-2	lb.	.16 /	.25
P-370	lb.	.175 /	.25
X-210	lb.	.12 /	.22
Freeze-Stabilizer 322	lb.	.40	
12116C	lb.	.52	
Gelling Agent P-397	lb.	.34 /	
Igepon T-43	lb.	.145 /	.35
T-51	lb.	.125 /	.285
-73	lb.	.285 /	.495
Indulins	lb.	.06 /	.08
Ludox	lb.	.1675/	.195
Marmix	lb.	.41 /	.48
Merac	lb.	.75 /	1.05
Micronex, colloidal	lb.	.06 /	.072
Monsanto Blue 4685 WD	lb.	1.60	
Green 4884 WD	lb.	1.80	
Red 127	lb.	1.25	
OPD-101	lb.	.16 /	.26
Pliolite Latex 150, 190	lb.	.32 /	.41
170	lb.	.37 /	.46
Polyvinyl methyl ether	lb.	.25 /	.45
Resin V	lb.	.13	
Roelgel 100C	lb.	.46	
Santomerse D	lb.	.44 /	.65
S	lb.	.13 /	.25
Sellogen Gel	lb.	.1275	
Sequestrene AA	lb.	.905 /	.975
30A	lb.	.245 /	.265
ST	lb.	.585 /	.615
Setsit #5	lb.	.75 /	1.05
Stablex A	lb.	.80 /	1.10
B, G	lb.	.50 /	.95
K	lb.	.27 /	.35
P	lb.	.35 /	.50
T	lb.	.14 /	.22
Surfactol 13	lb.	.345 /	.36
Webnix	lb.	1.50 /	2.50

Mold Lubricants

Acintol D	lb.	.06 /	.075
A-C Polyethylene	lb.	.30 /	.37
Akro Gel	lb.	.165	
Alipal CO-433	lb.	.25 /	.45
CO-436	lb.	.22 /	.41
Aquarex Compounds	lb.	.21 /	.94
Carbowax 200, 300, 400	lb.	.22 /	.25
1500	lb.	.255 /	.2825
4000	lb.	.31 /	.32
6000	lb.	.35 /	.36
Castorwax	lb.	.21 /	.27
Colite Concentrate	gal.	.90 /	1.15
D-Tak Dip #10	gal.	1.50	
ELA	lb.	$0.82	
DC Mold Release Fluid	lb.	3.14 /	$4.75
Compound 4, 7	lb.	5.13 /	6.50
Emulsion 7	lb.	1.59 /	2.07
8, 35, 35A, 35B, 36	lb.	1.26 /	1.80
200 Fluid	lb.	3.14 /	4.75
Glycerized Liquid Lubricant, concentrated	gal.	1.48 /	1.63
Igepals	lb.	.2875/	.74
Igepon AP-78	lb.	.44 /	.68
T-43	lb.	.145 /	.35
-51	lb.	.125 /	.285
-73	lb.	.285 /	.495
Lubrex	lb.	.25 /	.30
Lubri-Flo	gal.	10.00 /	12.05
Lustermold	lb.	.41	
Mold Paste	lb.	.25	
Monopole Oil	lb.	.16	
Monten Wax	lb.	.57	
Para Lube	lb.	.046 /	.048
Plaskon 8406, 8407	lb.	.30 /	.37
8416, 8417	lb.	.35 /	.42
8429	lb.	.40 /	.47
Pluronics	lb.	.335 /	.44
Polyglycol E series	lb.	.29 /	.42
Rubber-Glo	gal.	.94 /	.97
SM-33, -55, -61	lb.	1.26 /	1.80
Soap, Hawkeye	lb.	1.35 /	1.45
Purity	lb.	.155 /	.165
Sodium stearate	lb.	.40	
Stoner's 700 series	gal.	1.20 /	1.25
800 series	gal.	1.26 /	1.70
900 series	gal.	1.55 /	2.55
A Series	gal.	1.80 /	4.50
Ucon 50-HB Series	lb.	.25 /	.375
Ulco	lb.	.12 /	.23
Vanfre	gal.	2.50 /	3.00

Odorants

Alamasks	lb.	.75 /	6.50
Coumarin	lb.	2.95 /	3.55
Curodex 19	lb.	4.75 /	5.05
188	lb.	5.75	
198	lb.	6.75	
Ethavan	lb.	6.75 /	7.35
Latex Perfume #7	lb.	4.00	
Neutroleum Gamma	lb.	3.60	
Rubber Perfume #10	lb.	2.60	
Vanillin, Monsanto	lb.	3.00 /	3.15

Plasticizers and Softeners

Acintol R	lb.	.065 /	.07
Adipol 2EH, 10A	lb.	.425 /	.455
BCA	lb.	.45 /	.475
ODY	lb.	.47 /	.50
Admex 710	lb.	.325	
711	lb.	.345	
744	lb.	.40	
Aro Lene #1980	lb.	.10 /	.12
Baker AA Oil	lb.	.195 /	.24
Crystal O Oil	lb.	.21 /	.255
Processed oils	lb.	.215 /	.235
Bardol, 639	lb.	.215 /	.235
B	lb.	.0625/	.065
Benzoflex 2-45	lb.	.26 /	.29
9-88	lb.	.27 /	.30
Bondogen	lb.	.55 /	.60
BRC 20	lb.	.15 /	.175
22	lb.	.025 /	.0275
30	lb.	.0125/	.021
521	lb.	.019 /	.02
BRH 2	lb.	.0213/	.0351
BRS 700	lb.	.02 /	.0285
BRT 7	lb.	.03 /	.031
BRV	lb.	.0475/	.0565
Bunarex Liquid	lb.	.0425/	.0555
Resins	lb.	.065 /	.1225
Bunnatol G, S	lb.	.40 /	.505
Butac	lb.	.125 /	.135
Butyl stearate, comml.	lb.	.255	
Binney & Smith	lb.	.23 /	.26
Hardesty	lb.	.23 /	.26
Ohio-Apex	lb.	.22 /	.25
BxDC	lb.	.40 /	.41
Cabflex HS-10	lb.	.44 /	.47
Califlux 510, 550	lb.	.025 /	.0325
G. P.	lb.	.0125/	.02
R-100	lb.	.045 /	.0525
T T	lb.	.017 /	.0245
Capryl alcohol, comml.	lb.	.195 /	.235
Binney & Smith	lb.	.18 /	.28
Hardesty	lb.	.18 /	.28
Chlorowax 40	lb.	.1625/	.1825
70	lb.	.185 /	.245
-S	lb.	.21 /	.27
Contogums	lb.	.0875/	.111
Cumar Resins	lb.	.065 /	.17
DBM (dibutyl-m-cresol)			
Darex	lb.	.52 /	.3475
DBP (dibutyl phthalate), comml.	lb.	.30 /	.33
Darex	lb.	.30 /	.33
Hatco	lb.	.30 /	.33
Monsanto	lb.	.30 /	.33
Naugatuck	lb.	.30 /	.33
Ohio-Apex	lb.	.30 /	.33
PX-104	lb.	.30 /	.33
Rubber Corp. of America	lb.	.30 /	.44
Sherwin-Williams	lb.	.30 /	.33
DBS (dibutylsebacate), comml.	lb.	.66 /	.69
Hatco	lb.	.66 /	.685
Monoplex	lb.	.66 /	.675
Naugatuck	lb.	.665 /	.69
PX-404	lb.	.665 /	.69
DCP (dicaprylphthalate), comml.	lb.	.295 /	.325
Hatco	lb.	.295 /	.325
Monoplex	lb.	.30 /	.315

DDA (didecyladipate)			
Cabflex	lb.	$0.425 /	$0.455
Good-rite GP-236	lb.	.425 /	.57
DDP (didecylphthalate)			
Cabflex	lb.	.305 /	.335
Good-rite GP-266	lb.	.305 /	.455
Hatco	lb.	.305 /	.435
Defoamer X-3	lb.	.355	
DIBA (diisobutyladipate)			
Cabflex	lb.	.4325/	.4625
Darex	lb.	.4325/	.4625
Ohio-Apex	lb.	.4325/	.4625
DIDA (diisodecyladipate)			
Monsanto	lb.	.425 /	.455
DIDP (diisodecylphthalate)			
Darex	lb.	.32 /	.35
Monsanto	lb.	.305 /	.335
Ohio-Apex	lb.	.305 /	.335
PX-120	lb.	.305 /	.335
Dielex B	lb.	.06	
Diethylene glycol, comml	lb.	.1525/	.1825
Wyandotte	lb.	.15 /	.165
Dinopol IDO	lb.	.305 /	.335
DIOA (diisooctyladipate)			
Cabflex	lb.	.425 /	.455
Naugatuck	lb.	.435 /	.465
PX-208	lb.	.425 /	.455
Rubber Corp. of America	lb.	.425 /	.56
DIOP (diisooctylphthalate), comml	lb.	.305 /	.335
Cabflex	lb.	.305 /	.335
Darex	lb.	.32 /	.35
Hatco	lb.	.305 /	.335
Monsanto	lb.	.305 /	.335
Naugatuck	lb.	.305 /	.335
Ohio-Apex	lb.	.305 /	.335
PX-108	lb.	.305 /	.335
Rubber Corp. of America	lb.	.305 /	.45
Sherwin-Williams	lb.	.32 /	.34
DIOS (diisooctylsebacate), comml	lb.	.61 /	.64
Rubber Corp. of America	lb.	.61 /	.84
DIOZ (diisooctylazelate)			
Cabflex	lb.	.48 /	.51
Dipolymer Oil	gal.	.33 /	.38
Dispersing Oil No. 10	lb.	.06 /	.0625
DNODP (di-n-octyl-n-decyl phthalate), Monsanto	lb.	.345 /	.375
DOA (dioctyladipate), comml	lb.	.425 /	.455
Cabflex	lb.	.425 /	.455
Good-rite GP-233	lb.	.425 /	.57
Hatco	lb.	.435 /	.465
Monsanto	lb.	.425 /	.455
Naugatuck	lb.	.435 /	.465
PX-238	lb.	.425 /	.455
Rubber Corp. of America	lb.	.425 /	.56
DOP (dioctylphthalate), comml	lb.	.305 /	.335
Cabflex	lb.	.305 /	.335
Darex	lb.	.32 /	.35
Good-rite GP-261	lb.	.305 /	.455
Hatco	lb.	.305 /	.335
Monsanto	lb.	.305 /	.335
Naugatuck	lb.	.305 /	.335
Ohio-Apex	lb.	.305 /	.335
PX-138	lb.	.305 /	.335
Rubber Corp. of America	lb.	.305 /	.45
Sherwin-Williams	lb.	.32 /	.34
DOS (dioctylsebacate), comml	lb.	.61 /	.64
Hatco	lb.	.61 /	.635
Monoplex	lb.	.61 /	.635
Naugatuck	lb.	.615 /	.64
PX-438	lb.	.615 /	.64
Rubber Corp. of America	lb.	.61 /	.84
Drapex 3.2	lb.	.40 /	.45
Dutch Boy NL-A10 (DBP)	lb.	.30 /	.33
-A20 (DOP), A30 (DIOP)	lb.	.305 /	.335
-A54	lb.	.295 /	.325
-C20 (DOS)	lb.	.61 /	.63
-F21	lb.	.395 /	.425
-F31	lb.	.44 /	.47
-F41	lb.	.48 /	.51
Dutrex 6	lb.	.025 /	.035
Emulphor EL-719	lb.	.52 /	.73
Ethox	lb.	.43 /	.455
Ethylene glycol, comml	lb.	.135 /	.165
Wyandotte	lb.	.1325/	.1425
Flexol 3 GH	lb.	.44 /	.46
3 GO	lb.	.53 /	.55
4 GO	lb.	.325 /	.355
10-A	lb.	.425 /	.455
426	lb.	.27 /	.30
810, 810X, 10-10, 10-10X	lb.	.305 /	.335
TOF, A-26	lb.	.435 /	.465
Flexricin P-1	lb.	.295 /	.31
P-4	lb.	.285 /	.30
P-8	lb.	.305 /	.32
PG-16	lb.	.335 /	.35
Fortex	lb.	.125 /	.145
G. B. Asphaltic Flux	gal.	.08 /	.14
Naphthenic Neutrals	gal.	.11 /	.18
Process oil, light	lb.	.025 /	.0325
Medium	lb.	.035 /	.0425
Galex W-100	lb.	.155 /	.18
W-100 D	lb.	.1525/	.1775
Gilsowax B	lb.	.0975/	.11
Harchemex	lb.	.25 /	.34
Harflex 10	lb.	1.25 /	1.335
40	lb.	.64 /	.725
50, 80, 300	lb.	.58 /	.665
60	lb.	.62 /	.705
90	lb.	.88 /	.965
120, 150	lb.	.305 /	.395
140, 160	lb.	.30 /	.33
180	lb.	.295 /	.38
220, 250	lb.	.425 /	.515
260	lb.	.42 /	.45

Harflex 280	lb.	$0.42 /	$0.51
500	lb	.315 /	.405
HB-20	lb.	.15 /	.17
-40	lb.	.19 /	.21
Heavy Resin Oil	lb.	.0225/	.0375
HSC-13	lb.	.27 /	.30
Indonex	gal.	.11 /	.19
Kapsol	lb.	.3225/	.3525
Kenflex A, L	lb.	.26 /	.27
B	lb.	.23 /	.24
N	lb.	.18 /	.19
Kessoflex 103	lb.	.405	
105	lb.	.3325	
106	lb.	.38	
107	lb.	.525	
110	lb.	.24	
111	lb.	.28	
KP-23	lb.	.29 /	.32
-90	lb.	.40 /	.43
-140	lb.	.46 /	.485
KP-201	lb.	.5825/	.5925
-220	lb.	.31 /	.34
-555	lb.	.45 /	.475
Kronisol	lb.	.33 /	.355
Kronitex AA, I, K-3, Mx	lb.	.345 /	.375
Marvinol plasticizers	lb.	.28 /	.8825
Methox	lb.	.385 /	.41
Monoplex S-38	lb.	.215 /	.24
S-71	lb.	.45 /	.475
Morflex	lb.	.25 /	.65
Natac	lb.	.12 /	.13
Neoprene Peptizer P.-12	lb.	1.05	
Nevillac	lb.	.39 /	.85
Neville R Resins	lb.	.15 /	.35
Nevinol	lb.	.20	
No. 1-D heavy oil	lb.	.065	
ODA (octyldecyladipate)			
Cabflex	lb.	.425 /	.455
Good-rite GP-235	lb.	.425 /	.57
ODP (octyldecylphthalate)			
Cabflex	lb.	.305 /	.335
Good-rite GP-265	lb.	.305 /	.455
Hatco	lb.	.305 /	.335
Rubber Corp. of America	lb.	.305 /	.45
Ohopex R-9	lb.	.3525/	.3775
Q-10	lb.	.295 /	.325
Orthonitro benzophenol, comml	lb.	.13 /	15
Monsanto	lb.	.13 /	.15
Palmalene	lb.	.15	
Panaflex BN-1	lb.	.185 /	.225
Para Flux, regular	gal.	.10 /	.2125
No. 2016	gal.	.165 /	.24
2332	gal.	.11	
4205	lb.	.1075/	.2125
Para Lube	lb.	.046 /	.048
Resins	lb.	.04 /	.045
Paradene Resins	lb.	.065 /	.075
Paraplex 5-B	lb.	.29 /	.3475
AL-111	lb.	.32 /	.3275
G-25	lb.	.76 /	.77
-40	lb.	.51 /	.52
-50	lb.	.4025/	.4275
-53	lb.	.45 /	.475
-60	lb.	.325 /	.35
-62	lb.	.345 /	.37
RG-7	lb.	.33 /	.335
-8	lb.	.505 /	.5125
-10	lb.	.52 /	.5275
Pepton 22	lb.	.79 /	.82
Philrich 5	gal.	.11	
Picco Resins	lb.	.135 /	.195
480 Oilproof Series	lb.	.18 /	.23
Aromatic Plasticizers	lb.	.05 /	.065
Liquid Resin D-165 (Y)	lb.	.06 /	.075
(Z-3)	lb.	.07 /	.085
(Z-6)	lb.	.08 /	.095
S. O. S.	gal.	.29 /	.34
Piccocizers	lb.	.04 /	.055
Piccolastic Resins	lb.	.1855/	.34
Piccolyte Resins	lb.	.185 /	.25
Piccopale Resins	lb.	.12 /	.135
Piccovars	lb.	.165 /	.20
Piccovol	lb.	.025 /	.038
Pictar	gal.	.25 /	.30
Pigmentar	lb.	.046 /	.0745
Pigmentaroil	lb.	.046 /	.0745
Pine Tar, Sunny South	lb.	.046 /	.0801
Oil, Sunny South	lb.	.046 /	.0801
Pitch, Burgundy, Sunny South	lb.	.1030/	.1085
Plasticizers			
42	lb.	.34 /	.40
B	lb.	.35 /	.45
DP-520	lb.	.435 /	.455
MP	lb.	.035 /	.0755
MT-511	lb.	.535 /	.565
ODN	lb.	.32 /	.37
SC	lb.	.54 /	.63
Plastoflex #3	lb.	.52 /	.57
#520	lb.	.36 /	.435
DBE	lb.	.50 /	.55
MGB	lb.	.32 /	.40
SP-2	lb.	.43 /	.48
VS	lb.	.40 /	.475
Plastogen	lb.	.0775/	.08
Plastone	lb.	.22 /	.3075
Polycin 470	lb.	.275 /	.29
Polycizers	lb.	.40 /	.47
Polymel D	lb.	.225 /	.235
DX, C-130	lb.	.1375/	.1475
C-128	lb.	.1775/	.1875
D-TAC	lb.	.1975/	.215
PT67 Light Pine Oil	gal.	.60	
101 Pine Tar Oil	lb.	.046 /	.0634
Pine Tars	lb.	.046 /	.0634
R-19, R-21 Resins	lb.	.1075	
Reogen	lb.	.1325/	.135

Resin C pitch	lb.	$0.0225/	$0.031
R6-3	lb.	.38 /	.40
Resinex 10, 25, 50, 110	lb.	.04 /	.045
70	lb.	.0325/	.0375
85, 100	lb.	.035 /	.04
115	lb.	.0375/	.0425
L-2, L-3, L-4, L-5	lb.	.0225/	.03
Rosin Oil, Sunny South	gal.	.58 /	.875
RPA No. 2	lb.	.78	
3	lb.	.47	
Conc.	lb.	.97	
5	lb.	.59	
RSN Flux	gal.	.10 /	.19
Rubber Oil B-5	lb.	.0225/	.0355
Rubberol	lb.	.2575/	.2725
Santicizer 1-H	lb.	.50 /	.51
3	lb.	.46 /	.47
8	lb.	.43 /	.44
9	lb.	.39 /	.42
140	lb.	.33 /	.36
Santicizer-141	lb.	.34 /	.37
160	lb.	.25 /	.28
601	lb.	.325	
602	lb.	.305	
B-16	lb.	.4875/	.4975
E-15	lb.	.5075/	.5375
M-17	lb.	.4275/	.4575
Sebacic acid, purified, comml	lb.	.59 /	.65
Binney & Smith	lb.	.64 /	.76
Hardesty	lb.	.64 /	.76
C.P.-Binney & Smith	lb.	.72 /	.84
Hardesty	lb.	.72 /	.84
Sherolatum Petrolatum	lb.	.05 /	.10
Softener #20	gal.	.10 /	.20
Special Rubber Resin 100	lb.	.1675/	.2175
Staflex AX	lb.	.43	
DBES	lb.	.61 /	.635
Syn-Tac	gal.	.33 /	.35
Synthol	lb.	.2475	
Thiokol TP-90B	lb.	.59	
-95	lb.	.65	
Tricresyl phosphate, comml	lb.	.33 /	.36
Cabflex	lb.	.345 /	.375
Monsanto	lb.	.33 /	.36
Naugatuck	lb.	.33 /	.36
PX-917	lb.	.33 /	.36
Triphenyl phosphate, comml	lb.	.39 /	.40
Monsanto	lb.	.39 /	.40
Turgum S	lb.	.1075/	.1175
Tysonite	lb.	.24 /	.2475
United	gal.	.69 /	1.20
X-1 Resinous Oil	lb.	.021 /	.0275

Reclaiming Oils

Acintol C, P	lb.	.02 /	.03
Bardol, 639	lb.	.0275/	.0375
B	lb.	.0625/	.065
BRH 2	lb.	.0213/	.0351
BRT 3	lb.	.018 /	.0265
4	lb.	.025 /	.026
7	lb.	.03 /	.031
BRV	lb.	.0475/	.0565
Burco-RA	lb.	.053 /	.0805
BWH-1	lb.	.16 /	.18
Dipolymer Oil	gal.	.33 /	.43
Dispersing Oil No. 10	lb.	.06 /	.0625
G. B. Oils	gal.	.10 /	.24
Heavy Resin Oil	lb.	.0225/	.0375
I.X-777	gal.	.23 /	.33
No. 3186	gal.	.28 /	.295
Picco 6535	gal.	.25 /	.30
C-33	gal.	.215 /	.315
-42	gal.	.23 /	.33
D-4	gal.	.27 /	.37
E-5	gal.	.25 /	.35
Q-Oil	gal.	.286 /	.36
PT 67	gal.	.60	
101 Pine Tar Oil	lb.	.0427/	.0610
150 Pine Solvent	gal.	.44	
Reclaiming Oil #3186	gal.	.28 /	.385
-G	gal.	.25 /	.365
4039-M	gal.	.3275/	.3975
-Y	gal.	.30 /	.37
RR-10	lb.	.36	
S. R. O.	lb.	.015 /	.0225
X-1 Resinous Oil	lb.	.021 /	.03

Reinforcers, Other Than Carbon Black

American Resinous Chemical			
978-42B	lb.	.18 /	.19
1073-18B	lb.	.135 /	.145
1294-36B	lb.	.115 /	.125
1301-12B	lb.	.15 /	.16
Angelo Shellacs	lb.	.485 /	.7325
BRC 20	lb.	.15 /	.175
22	lb.	.025 /	.0275
30	lb.	.0125/	.021
521	lb.	.019 /	.02
Bunarex Resins	lb.	.065 /	.1225
Cab-o-sil	lb.	.68 /	.75
Calcene NC	ton	72.50 /	92.50
TM	ton	75.00 /	95.00
Calco S. A.	lb.	.85 /	.88
Clays			
Aiken	ton	14.00	
Buca	ton	45.00	
Burgess HC-75	ton	12.00 /	30.00
HC-80	ton	14.00 /	32.00
Iceberg	ton	50.00 /	60.00
Pigment No. 20	ton	35.00 /	60.00
30	ton	37.00 /	60.00
Catalpo	ton	35.00	
Crown	ton	14.00 /	33.00
Dixie	ton	14.00	
Franklin	ton	13.50 /	35.25
L. G. B.	ton	17.00	

Clays (*cont'd*)

Paragon	*ton*	$13.50	/ $33.00
Pigment No. 33	*ton*	37.00	
Recco	*ton*	14.00	
Suprex	*ton*	14.00	/ 33.50
Swanee	*ton*	12.50	
Whitetex	*ton*	50.00	
Windsor	*ton*	14.00	/ 30.00
Witco No. 1	*ton*	14.00	/ 30.00
No. 2	*ton*	13.50	/ 30.00
Clearcarb	*lb.*	.1175	/ .1255
Cumar Resins	*lb.*	.065	/ .17
Darex Resins	*lb.*	.42	/ .49
Diatomaceous silica	*ton*	32.00	/ 48.00
Good-rite Resin 50	*lb.*	.39	/ .41
K Series Polymers	*lb.*	.15	/ .37
Hi-Sil 101	*lb.*	.10	/ .115
233	*lb.*	.09	/ .105
X303	*lb.*	.40	/ .45
Hycar 2001	*lb.*	.55	
2007	*lb.*	.39	
Indulins	*lb.*	.06	/ .08
Kralac A-EP	*lb.*	.43	/ .54
Laminar	*ton*	30.00	
Magnesium carbonate, Merck	*lb.*	.105	/ .12
Marbon Resins	*lb.*	.39	/ .46
Multifex MM	*ton*	110.00	/ 125.00
Super	*ton*	160.00	/ 175.00
Neville Resins			
465	*lb.*	.07	/ .0825
G	*lb.*	.13	
LX-509	*lb.*	.35	
Nebony	*lb.*	.04	/ .0575
Paradene	*lb.*	.065	/ .075
R	*lb.*	.13	/ .18
Para Resins 2457, 2718	*lb.*	.04	/ .45
Parapol S-Polymers	*lb.*	.44	
Picco Resins	*lb.*	.13	/ .185
Piccolyte Resins	*lb.*	.205	/ .275
Piccoumaron Resins	*lb.*	.07	/ .19
Piccovars	*lb.*	.145	/ .20
Pliolite NR types	*lb.*	.98	/ 1.33
S-3, -6	*lb.*	.42	/ .49
-6B	*lb.*	.39	/ .46
Purecal M	*ton*	56.75	/ 71.75
SC, T	*ton*	110.00	/ 125.00
U	*ton*	120.00	/ 135.00
R-B-H 510	*lb.*	.15	/ .22
Resinex	*lb.*	.0325	/ .0425
Rubber Resin LM-4	*lb.*	.28	/ .35
Silene EF	*ton*	120.00	/ 140.00
Silvacons	*ton*	55.00	/ 85.00
Witcarb R	*ton*	105.00	/ 120.00
-12	*ton*	45.00	/ 66.00
Zeolex 23	*ton*	120.00	/ 140.00
Zinc oxide, commercial†	*lb.*	.135	/ .1775

Retarders

Benzoic acid TBAO-2	*lb.*	.44	
E-S-E-N	*lb.*	$0.35	/ $0.37
Good-rite Vultrol	*lb.*	.62	/ .66
R-17 Resin	*lb.*	.1075	/ .36
Retarder ASA	*lb.*	.57	
J	*lb.*	.62	/ .64
PD	*lb.*	.35	/ .37
W	*lb.*	.45	
Retardex	*lb.*	.47	/ .50
Thionex	*lb.*	1.14	

Solvents

Bondogen	*lb.*	.55	/ .60
Butyrolactone	*lb.*	.60	/ .65
Cosol #1	*gal.*	.37	/ .43
#2	*gal.*	.42	/ .48
Dichloro Pentanes	*lb.*	.04	/ .07
Dipentene DD, Sunny South	*gal.*	.40	/ .62
Ethylene dichloride, comml.	*lb.*	.09	/ .1225
Hi-Flash 2-50-W	*gal.*	.41	
Pale yellow	*gal.*	.39	
LX-572	*gal.*	.27	/ .32
-748	*gal.*	.16	/ .23
n-Methyl-2-pyrrolidone	*lb.*	.75	/ .80
Neville Nos. 100, 104	*gal.*	.52	/ .60
106	*gal.*	.38	/ .46
Nevsol B	*gal.*	.20	/ .30
H, 200	*gal.*	.19	/ .29
HF, T, 30	*gal.*	.24	/ .34
Penetrell	*gal.*	.40	/ .62
Picco Hi-Solv Solvents	*gal.*	.16	/ .48
Pine Oil DD, Sunny South	*lb.*	.1225	/ .1425
PT 150 Pine Solvent	*gal.*	.44	
Skellysolve-E	*gal.*	.153	
-H	*gal.*	.133	
-R, -V	*gal.*	.109	
-S	*gal.*	.099	
Stauffer Carbon Disulphide	*lb.*	.0525	/ .085
Tetrachloride	*lb.*	.0825	/ .475

Synthetic Rubber Monomers

Dow Styrene N99, H99	*lb.*	.205	
RG	*lb.*	.17	
Vinyltoluene	*lb.*	.17	
Hylene T	*lb.*	1.15	
TM, TM-65	*lb.*	1.05	
Monomer MG-1	*lb.*	1.00	/ 1.25
Rohm & Haas ethyl acrylate	*lb.*	.34	
Methyl acrylate	*lb.*	.37	
Methacrylate	*lb.*	.29	/ .31

Synthetic Rubber Shortstops

DDM	*lb.*	.75	/ .88
Thiostop K	*lb.*	.53	
N	*lb.*	.41	

Tackifiers

American Resinous Chemical			
A25, A26, 716-30	*lb.*	$0.18	/ $0.19
555-40R	*lb.*	.185	/ .205
620-32B	*lb.*	.20	/ .21
716-35	*lb.*	.17	/ .18
1041-21	*lb.*	.165	/ .175
Acintol R	*lb.*	.065	/ .07
Bardol, 639	*lb.*	.0275	/ .0375
BRH 2	*lb.*	.0213	/ .0351
Bunarex Resins	*lb.*	.065	/ .1225
Chlorowax 70	*lb.*	.18	/ .24
Contogums	*lb.*	.0875	/ .11
Cumar Resins	*lb.*	.065	/ .17
Galex W-100	*lb.*	.155	/ .17
W-100D	*lb.*	.1525	/ .1625
Indopol H-35	*gal.*	.65	/ .81
H-50	*gal.*	.70	/ .86
-100	*gal.*	.85	/ 1.05
-300	*gal.*	1.00	/ 1.21
L-10	*gal.*	.40	/ .56
-50	*gal.*	.45	/ .61
-100	*gal.*	.55	/ .71
Kenflex resins	*lb.*	.18	/ .27
Koresin	*lb.*	.90	/ 1.10
Natac	*lb.*	.12	/ .13
Nevindene	*lb.*	.15	/ .18
Picco Resins	*lb.*	.13	/ .185
Piccolastic Resins	*lb.*	.1855	/ .34
Piccolyte Resins	*lb.*	.185	/ .25
Piccopale Resins	*lb.*	.089	/ .13
Piccoumaron Resins	*lb.*	.07	/ .185
R-B-H 510	*lb.*	.15	/ .22
Roelflex 1118A	*lb.*	.39	
Synthetic 100	*lb.*	.41	
Synthol	*lb.*	.2475	/ .2625
United	*gal.*	.69	/ 1.20

Vulcanizing Agents

Dibenzo G-M-F	*lb.*	2.60	
G-M-F #113, #117	*lb.*	.90	
Ko-Blend I, S	*lb.*	.39	
Litharge (*See Accelerator-Activators, Inorganic*)			
Magnesium oxide	*lb.*	.2525	/ .38
Merck, Light Calcined	*lb.*	.2525	/ .26
Extra Light Calcined	*lb.*	.2925	/ .30
Red Lead (*See Accelerator-Activators, Inorganic*)			
Sufsal R	*lb.*	1.50	
Sulfur flour, comml.	*100 lbs.*	2.30	/ 3.05
Aero	*100 lbs.*	2.15	/ 7.50
Crystex	*lb.*	.195	/ .23
Insoluble 60	*lb.*	.125	/ .13
Rubbermakers	*100 lbs.*	2.40	/ 4.30
Stauffer	*lb.*	.024	/ .0515
Telloy	*lb.*	2.50	
VA-7	*lb.*	.50	/ .60
Vandex	*lb.*	15.50	
Vultac No. 2	*lb.*	.47	/ .755
3	*lb.*	.51	/ .795
White lead silicate (*See Accelerator-Activators, Inorganic*)			

CALENDAR of COMING EVENTS

March 18-21
American Society of Mechanical Engineers. Spring Meeting. Multnomah Hotel, Portland, Oreg.

March 23
New York Rubber Group. Spring Meeting. Henry Hudson Hotel, New York, N. Y.

April 3
The Los Angeles Rubber Group, Inc. Hotel Statler, Los Angeles, Calif.

April 3-9
International Symposium on Macromolecular Chemistry. The Weizmann Institute of Science, Rehovot, Israel.

April 6
Akron Rubber Group. Hotel Mayflower, Akron, O.

April 8-13
American Chemical Society. One Hundred Twenty-Ninth National Meeting. Dallas, Tex.

April 9-10
AIEE, Subcommittee on Rubber & Plastics Industries. Eighth Annual Conference. Akron, O.

April 12
Fort Wayne Rubber & Plastics Group. Van Orman Hotel, Fort Wayne, Ind.

April 13
Philadelphia Rubber Group, Inc. Poor Richard Club, Philadelphia, Pa.

Detroit Rubber & Plastics Group, Inc. Detroit Leland Hotel, Detroit, Mich.

April 17
Elastomer & Plastics Group, Northeastern Section, ACS.

April 27
Chicago Rubber Group. Furniture Club, Chicago, Ill.

May 1
The Los Angeles Rubber Group, Inc. Hotel Statler, Los Angeles, Calif.

May 11
Buffalo Rubber Group. International Meeting.

May 15
Elastomer & Plastics Group, Northeastern Section, ACS. Fifth Annual Short Talks Symposium.

May 16-18
Division of Rubber Chemistry, ACS. Hotel Cleveland, Cleveland, O.

May 25
Connecticut Rubber Group.

May 28-30
Chemical Institute of Canada. Thirty-Ninth Annual Conference & Exhibition. Mt. Royal Hotel, Montreal, P.Q.

June 7
New York Rubber Group. Outing. Doerr's Grove, Millburn, N. J.

June 13
Buffalo Rubber Group. Outing.

June 15
Akron Rubber Group. Outing. Firestone Country Club, Akron, O.

Boston Rubber Group. Outing. Andover Country Club, Andover, Mass.

June 17-21
American Society of Mechanical Engineers. Semi-Annual Meeting. Hotel Statler, Cleveland, O.

June 20-21
Division of High-Polymer Physics, APS, and Division of Colloid Chemistry, ACS. Joint Symposium on "Diffusion" and "Flow Processes in Polymers." Madison, Wis.

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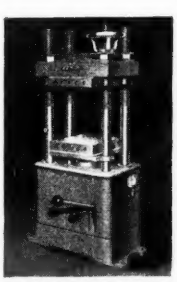

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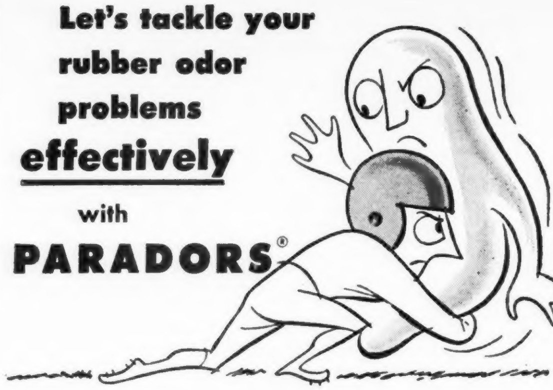

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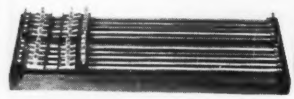

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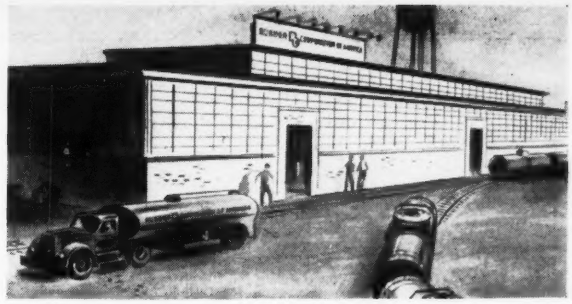

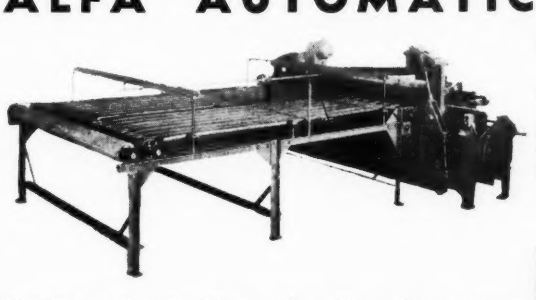

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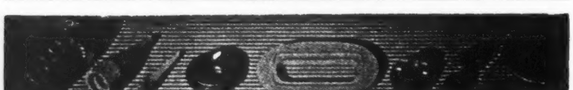

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